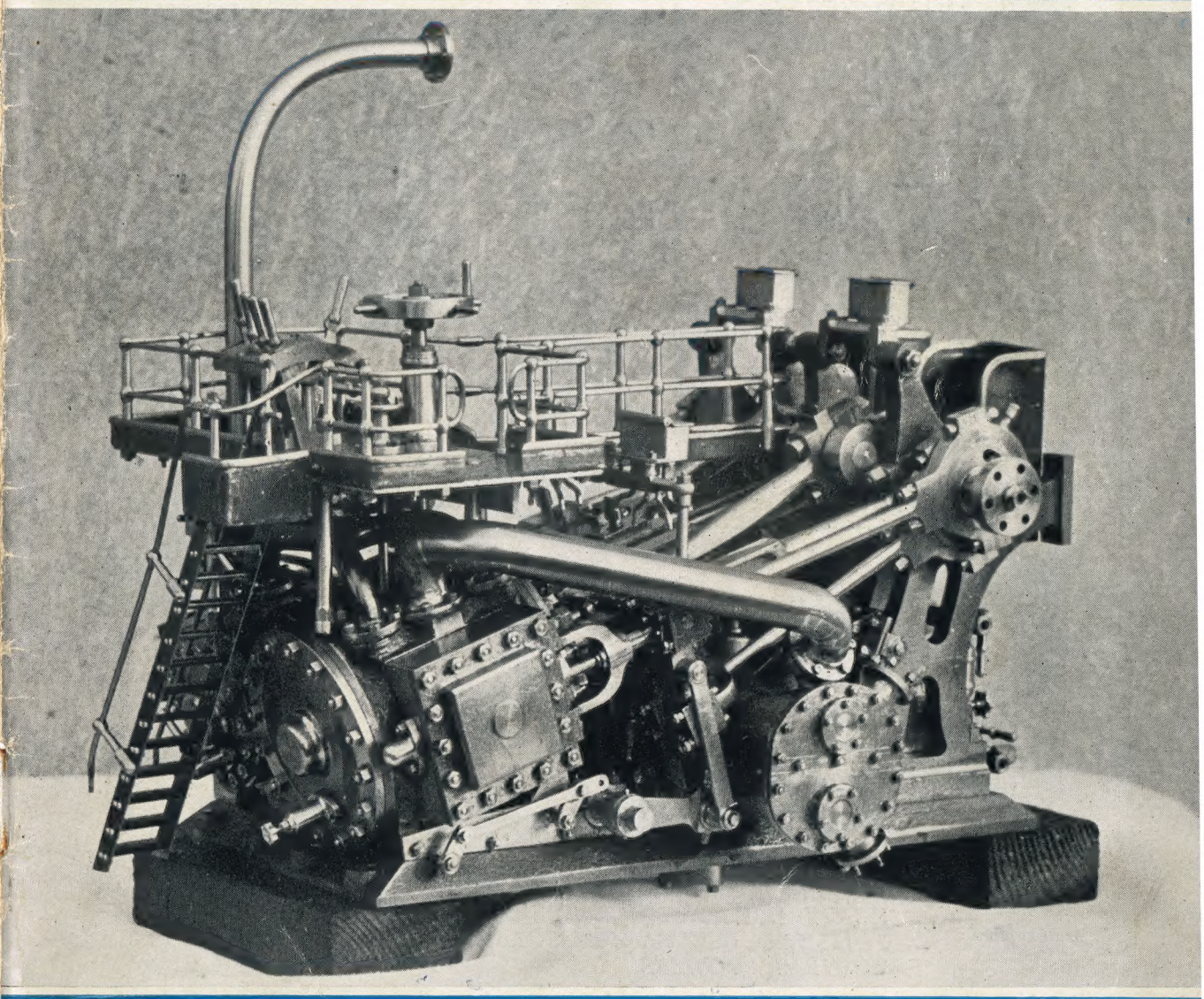
THE MODEL ENGINEER



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MAY 5th 1955

Vol. 112 No. 2815

9D

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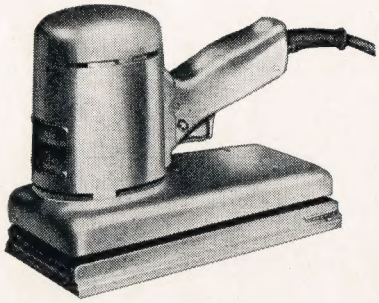

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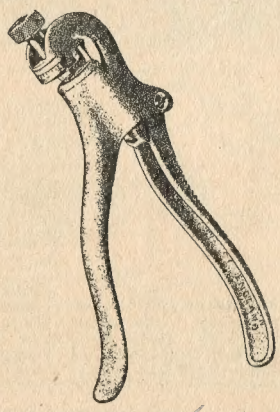

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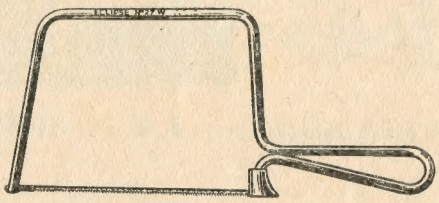

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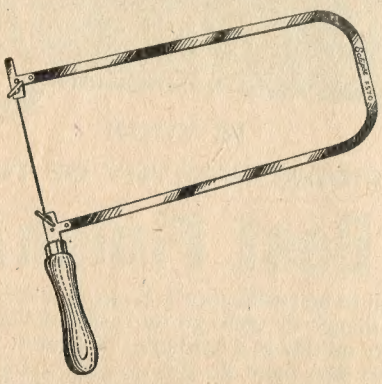

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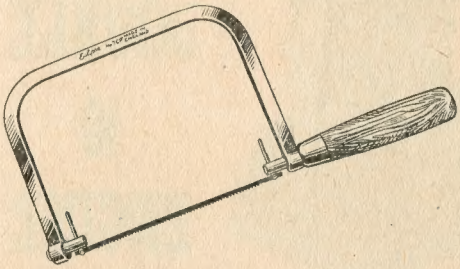

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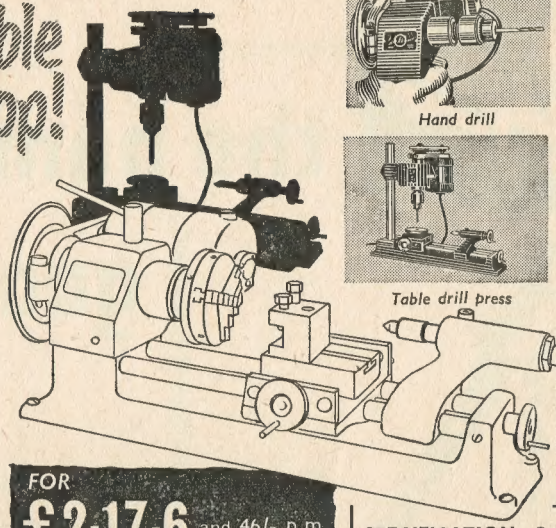

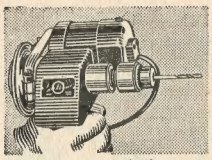

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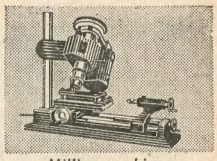

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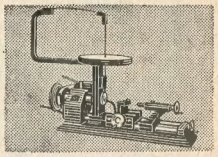

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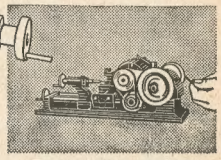

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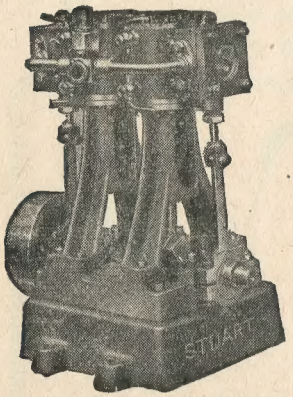

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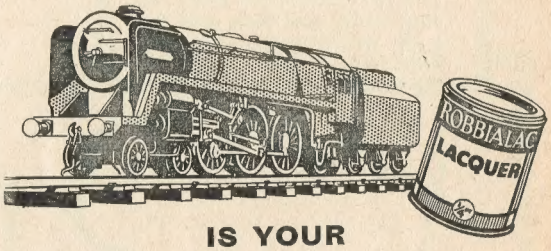

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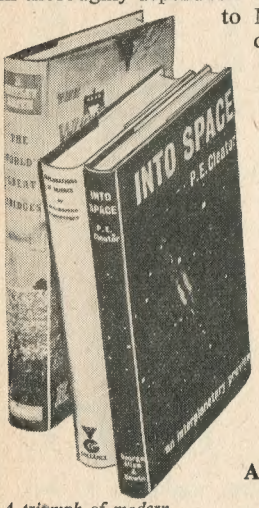

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MAY 5th - 1955

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OUR COVER PICTURE

Marine steam engines of all kinds give scope for the talent of the model engineers, and, of these, none are more interesting than those of paddle steamers, which are now rapidly becoming extinct. This model of a set of diagonal condensing paddle engines was built entirely from memory by Mr. R. F. Pluck, of Norwich, now 77 years old, who served on the steamers *Koh-I-Noor*, *Royal Sovereign* and *La Marguerite*, nearly 50 years ago. The h.p. cylinder is of 1 $\frac{9}{16}$-in. bore, l.p. 2$\frac{5}{8}$-in. bore, by 2½-in. stroke, and the overall dimensions of the model are 12½-in. length over baseplate, 9-in. width over crankshaft, and 5½-in. height. With the exception of iron castings of bedplate, main frames and cylinders, for which patterns were made, all parts are made from scrap material. The photograph was taken by Mr. Pluck, Junr., using an inexpensive pocket camera.

SMOKE RINGS

A "Gladiator" Echo

THE DESCRIPTION and photographs of the restored Burrell Showman's road locomotive, *Gladiator*, published in our March 17th issue, has awakened vivid memories for Mr. Harry Quick, of Mahanoy City, Pennsylvania, U.S.A., who writes:

"I was greatly interested to read of the purchase for preservation of the *Gladiator*. I was familiar with this engine, as a young man in England. The yearly visit of the Anderton & Rowland Venetian Gondolas to my home-town of Hayle, Cornwall, was an important event. To see this magnificent engine with her train of wagons pass by on the highway was a sight never to be forgotten; and on the showground the *Gladiator* was always given a place of prominence and was admired by both men and women. I have always believed that the English showmen and the great engine builders could have profited by the continuous interest shown in the steam engine, and could have modernised the engines to conform to modern transportation and power-generation needs, while preserving some of the features which made the engines objects of affection to the public."

We believe that all this *would* have been, but for the exorbitant taxation imposed upon the engines.

Interplanetary Research

IN VIEW of the widespread interest in the possibilities of space travel which prevails at present, especially among the younger generation, it has been suggested to us that this subject offers a fruitful field for amateur research, and that THE MODEL ENGINEER ought to give a practical lead in this matter by devoting space to articles on the subject, and publishing designs for space ships, rocket motors and the like. While we do our best to keep fully up to the times with all practical developments, and are by no means unmindful of the useful part which amateurs can and do play in various fields of research, we consider that there are some problems which are completely outside the sphere of the amateur, and it would appear that this is one of them.

For several years before the war, amateur interplanetary societies in several countries made valiant efforts to solve the problem of propelling a vehicle beyond the reach of the earth's gravitation, but though their work cannot be regarded as futile, it was not until national resources, under stress of war incentives and regardless of expense, were brought to bear on the matter that this first step towards interplanetary travel was remotely within possibility of attainment. Even in the light of modern knowledge, it is estimated that a ship capable of a one-way trip to the moon would cost tens of millions of pounds to construct, and this is well beyond the means of any amateur individual or society we know. At the risk of being deemed old-fashioned, we consider that model engineering, even in this mundane sphere, is not yet in need of fresh worlds to conquer, and can still make progress while keeping solidly down to earth.

Another B.R. Training School

WE HAVE received a copy of an illustrated brochure describing the new training school for apprentices at the Earlestown Carriage and Wagon Works of British Railways London Midland Region. The new school was opened on April 1st last by the chairman of the London Midland Area Board, Lord Rusholme, and is one of the best equipped of its kind in the country. It is one of a number which the London Midland is introducing throughout the region to give the best opportunities for boys wishing to follow a railway technical career. The underlying idea in providing these schools is to ensure that each entrant to the service gains a thorough knowledge of his craft and is encouraged to take a personal interest in the work that he performs. In the compilation of the curriculum, the boy's well-being, no less than his technical interests, have been carefully catered for, and there can be little doubt that the opening of this school at Earlestown will afford a notable advancement in the industrial life of the town.

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Telephone: GERrard 8811 Annual Subscription £2.2s.0d. post paid. (U.S.A. and Canada $6)

A Gearbox for a Twin-screw Boat

By R. H. Mapplebeck

THIS article has been written to show what can be done with very little equipment and knowhow, and to give a grain of comfort and encouragement to those not so fortunately placed as the model engineer who has, say, a milling machine, shaper, gear-cutting attachment, verticle-slide, etc., and who possesses that wonderful cornucopia which figures so prominently in model engineering articles, the "junk box," in which apparently anything can be found. It is, therefore, more to the other fellow who only has a few odd tools and a lathe that these notes are addressed; the man who, either through choice or because of circumstances, makes things the hard way, while his friends suggest that he could have bought the parts so laboriously made, for a shilling or two; those few shillings which, well-saved, have probably helped towards paying for the lathe.

Much has been written in the past on the correct way to machine gears and make gear-cutters, which is most interesting and useful to any model engineer, but there are undoubtedly many who, lacking the proper equipment and material, make do with very primitive methods. Indeed, it is safe to say that many a job has probably been shelved for this very reason alone. On the other hand, some wonderful work has been completed, using primitive tools and methods. It is really up to the man concerned how he makes out.

Knowledgeable folk reading these lines will probably raise their hands in horror at the methods employed: yet the gearbox about to be described, though made by the crudest means, has been in use in a radio-controlled twin-screw light cruiser for two years now, and has demonstrated both privately and publicly to everybody's satisfaction.

Of necessity, it is simple, and has a one-to-one ratio, employing an idler wheel to provide plenty of spacing with a small angle of dispersion between the propeller shafts, and avoid consequent noise and waste of energy at the universal couplings.

The scheme of the system is shown at Fig. 1, where it is seen that by using equal-sized gears for the three small pinions, the driving and driven shafts will rotate in opposite directions but with equal velocity.

The Gear Cutter

In the circumstances, it was decided that the easiest and cheapest way of cutting the gear teeth was to make a form tool shaped to the profile of a tooth, with the intention of eventually mounting it in the lathe tool-post and cutting one tooth at a time by operating the saddle backwards and forwards in the manner of a shaper, with the piece of brass which was to form the gear wheel mounted in the 3-jaw chuck (photograph 1).

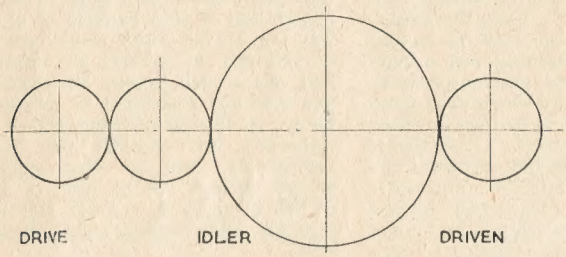


Fig. 1. Arrangement of gear train

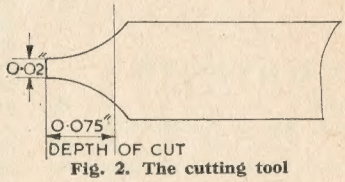


Fig. 2. The cutting tool

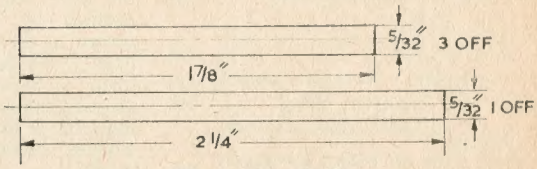
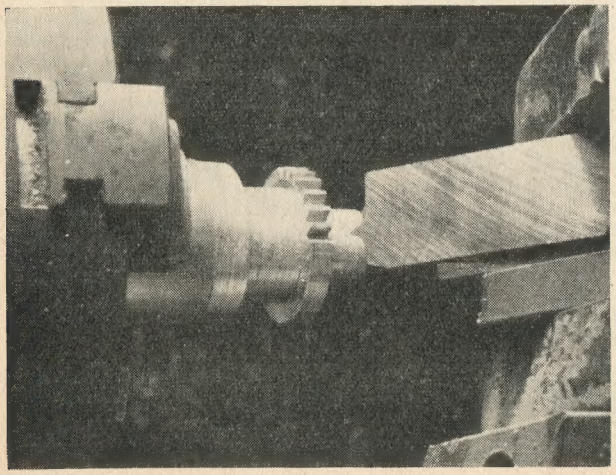
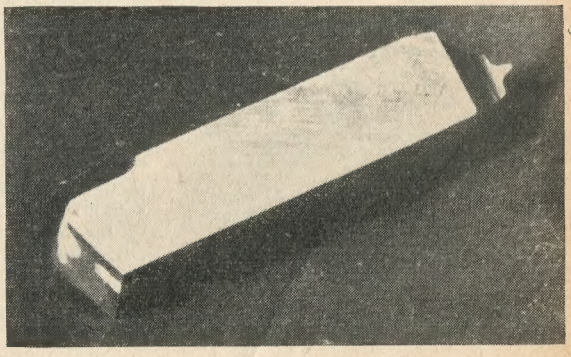


Fig. 4. The spindles

The forming tool was made from a piece of rust-stained tool-steel picked up for threepence on a stall in the local market, but it was a difficult task to grind it as near to the correct shape as possible without the aid of special





Photograph No. 2. The form tool

Left: Photograph No. 1. Cutting the teeth of a gear wheel

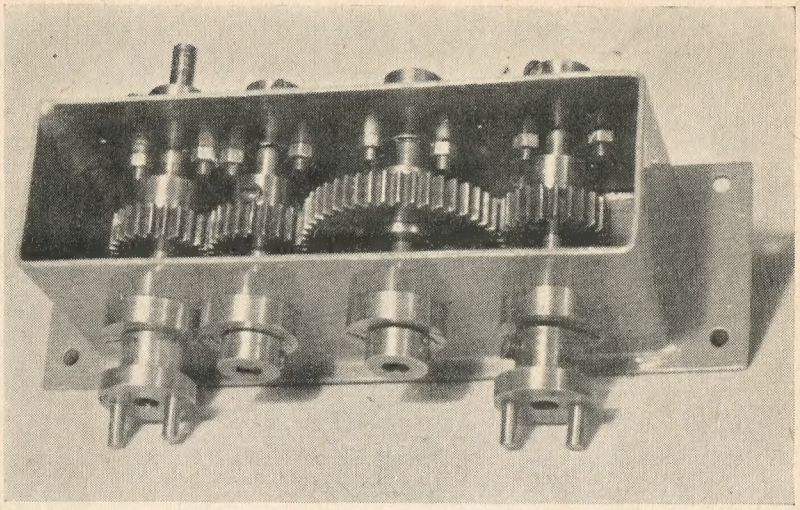
equipment. In short, it had to be done by eye, the profile being compared with one of the lathe change-wheel teeth, final touching up being carried out by hand with various slip-stones. As a result, the dimensions were haphazard, as once having obtained a reasonable tooth shape, it was thought inadvisable to fiddle about with the tool further (photograph 2).

The dimensions came out as shown at Fig. 2, and these, in conjunction with the proposed width of the shafts, were used to calculate the approximate size of the gear wheels, which it was anticipated would be roughtly $\frac{5}{8}$ in. o.d. for the small pinions, and about 1 in. o.d. for the large one. But before any cutting was attempted, it was necessary to make up some sort of dividing-head.

Articles have been published on how to use the change-wheels with a detent for this job, but when it came to the point, it was found that the number of teeth were not suitable for the number of teeth likely to be cut, so a crude dividing-head was "knocked up" by marking out a disc of $\frac{1}{16}$ in. aluminium, drilling the requisite number of holes round the periphery, and then mounting it on a tapered brass mandrel which was thrust into the hole in the headstock of the lathe, whilst a pointer, fixed to the bearing framework, acted as a rough locator. With the lathe in back gear, it was found that there was sufficient rigidity, without actually locking in position, to prevent the chuck moving from its set position whilst cutting each tooth; in this connection, it is advisable, when moving the chuck on for cutting the next tooth, to keep it moving in one direction only, to avoid errors due to backlash. In other words, there must be no jockeying for position in the absence of a detent locking device, so if the pointer on the dividing-head is found to have overshot, the chuck has to be either turned through 360 deg., or well back beyond the backlash point, and then brought forward again to the working position.

Before cutting the final gears, a test piece of brass of the appropriate diameter was chucked, and a few trial teeth cut, their profile examined for appearance, and the pitch checked with the aid of a micrometer.

With the tool shown, the gear dimensions came out as given in the table. The width of each tooth had to be the same as each portion cut out at the pitch circle, the final diameter of the wheel being dependent upon this, of course. The dimensions given, therefore, are only useful as a guide in describing the operation.



Photograph No. 3. Showing gearwheels mounted in position

If it is found that the teeth come out wider than the cut-away portion, it is a sign that the diameter is too great. This will necessitate turning down by a few thous., and running over the teeth again with the forming tool, until the teeth and the portions cut out are equal in width at the pitch circle.

Pinions	Diameter	Circum.	Number of teeth	Pitch
1 off large	1.212 in.	3.805 in.	46	0.083 in.
3 off small	0.636 in.	2.000 in.	24	0.083 in.

Gear dimensions.

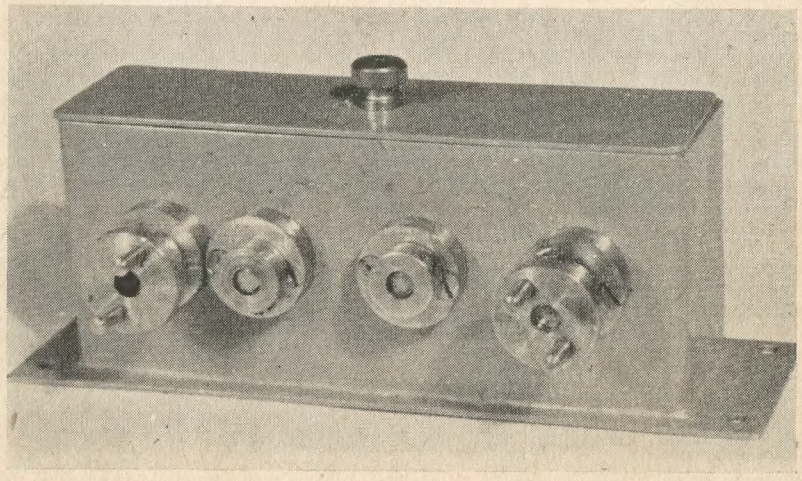
This probably seems a very lengthy process, but, in actual fact, the form tool is the only item that takes any length of time to make, the actual tooth cutting is quite a short process.

For instance, the large pinion with 46 teeth took only 20 minutes to cut, and in any case the whole process is so fascinating, to anyone who has not tried making their own gears before, that the time passes without one being aware of the fact.

At the start, the tool was fed in at 0.003 in. per cut, falling off to 0.001 in. per cut at maximum depth.

When all the teeth were cut, the burrs were removed by running the lathe normally and passing a sharp tool over the wheel faces. It was then centre-drilled, the spindle holes drilled, and the gearwheel finally parted off. The larger pinion was recessed on both faces, partly to reduce weight and partly to enhance appearance. Photograph 5.

The bosses were drilled and tapped to take 4-B.A. grub-screws, but, if it is considered not robust enough for a



Photograph No. 4. The completed gearbox

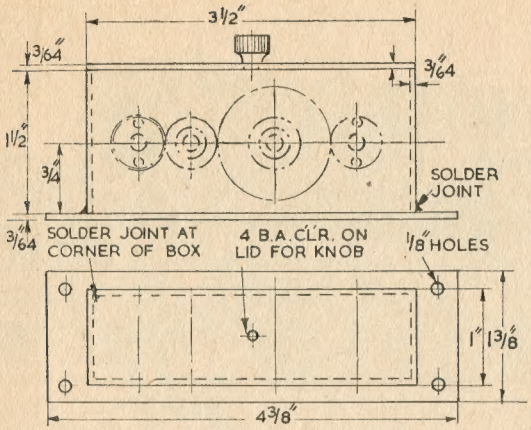


Fig. 5. Details of the gearbox

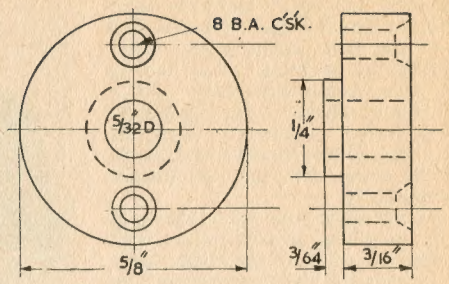


Fig. 6. The bronze bushes

particular job, there is no reason why the boss and shaft should not be drilled to take a 3/64-in. steel pin, thus preventing any possibility of slipping occurring between a gearwheel and its spindle.

The Spindles

The spindles were made of silver-steel 5/32 in. diameter, Fig. 4, and polished. It was not considered worthwhile hardening them in this instance, and after two years use, there is little sign of wear. But it can be done in the usual way, if desired.

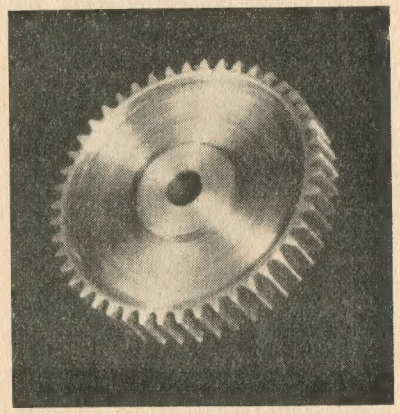
Gearbox Housing

Made by bending 3/64-in. brass sheet to the dimensions in Fig. 5, the corner and base being soft-soldered.

The cover plate had two pieces of flat spring soldered underneath, and bent over in the form of an inverted U, so that the springs gripped the sides of the box; it could be removed when required by a sharp pull of the brass knob, an old 4-B.A. battery terminal. Photograph 4.

Bearing Bushes

Phosphor-bronze was used for the spindle bearing bushes, and were turned with a spigot for locating on the gearbox casing. Fig. 6 and photograph 3. It was found best not to fit or drill the bushes until a later stage, the correct placing of them depending on the diameter of the gear wheels and their depth of meshing, which, of course, could be calculated once the pitch circle was known, but owing to slight errors of tooth shape, due to the unconventional method of cutting, the pitch-circle came slightly greater than it should. That is to say, the depth of mesh had to be found with the gears and spindles in position, clamped flat on the work bench, the distance between centres of the spindles being ascertained by measuring the distance between adjacent spindles with a micrometer and subtracting the diameter of one spindle. These measurements are not shown on the diagrams, as anybody employing this way of construction would never arrive at quite the same profile shape, with consequent variations in dimensions.



Photograph No. 5. A finished 46-tooth gear wheel

One way of locating the spindle centres is, first, to mount the undrilled bushes on the gearcase to the dimensions thus found, securing each one with two 8-B.A. countersunk-headed screws and nuts, and with the case on its side, place the gears in position on the bushes. Then with a pointed steel scriber made to the same diameter as the spindles, a centre pip may be marked on the bushes by passing the scribe through the spindle hole of each gearwheel. Although this may be unorthodox, like all the rest of the job, it proved satisfactory enough, as with these gears, small errors of meshing will hardly make much difference. However, in spite of all this, and with resulting meshing of the order of only 60 per cent. tooth depth, the gears have given good service.

If a verticle bench-mounted drilling machine is available, the holes in the bushes may be drilled right through, with the bushes mounted in position by means of their 8-B.A. screws, or failing a bench drill, the gearcase may be clamped on the lathe saddle for drilling, but make sure that it is square with the plane of the chuck.

The drill used should be a little smaller than 5/32 in., the holes finally being reamed out by passing the reamer right through the gearbox from side to side.

Assembling

With the spindle retaining-collars and shaft couplings (if required) made to Figs. 7 and 8, the wheels and spindles may be assembled in position, but it will almost certainly be found impossible to turn the spindles by hand, owing to excessive friction caused by the incorrect shape of the teeth. In the original construction, this was overcome by power-driving the gears from the lathe, gripping the driving spindle in the 3-jaw chuck and applying some fine grinding paste to the gear teeth, and a little light oil to the spindle bearings for

(*Continued on page* 498)

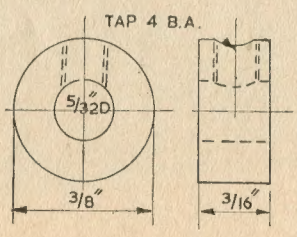


Fig. 7. Spindle retaining collars

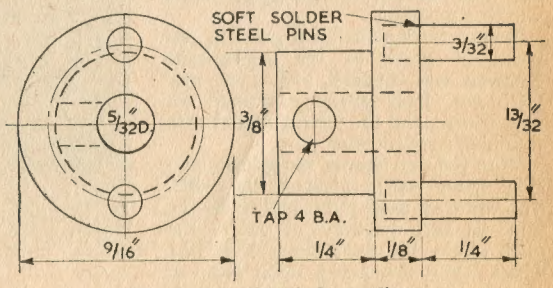


Fig. 8. Propeller shaft couplings

THE BLETCHLEY SOCIETY'S EXHIBITION

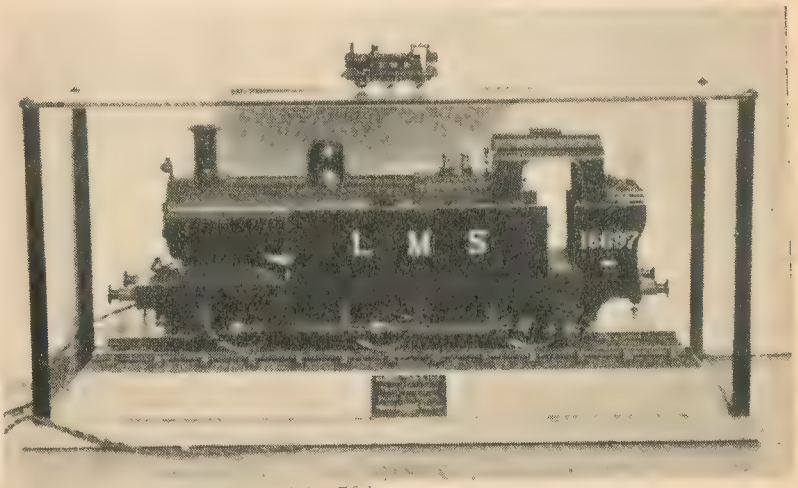
Reported by Geoffrey Deason

IT was difficult to believe, on visiting the third exhibition of the Bletchley & District M.E.S., that this very live society was actually disbanded due to lack of support soon after its initial formation in 1948. Re-formed and re-organised in 1952, it took a new lease of life and today it has a thriving membership, its own well-equipped workshop, and active sections devoted to live steam, boats, miniature railways, aircraft and electronics.

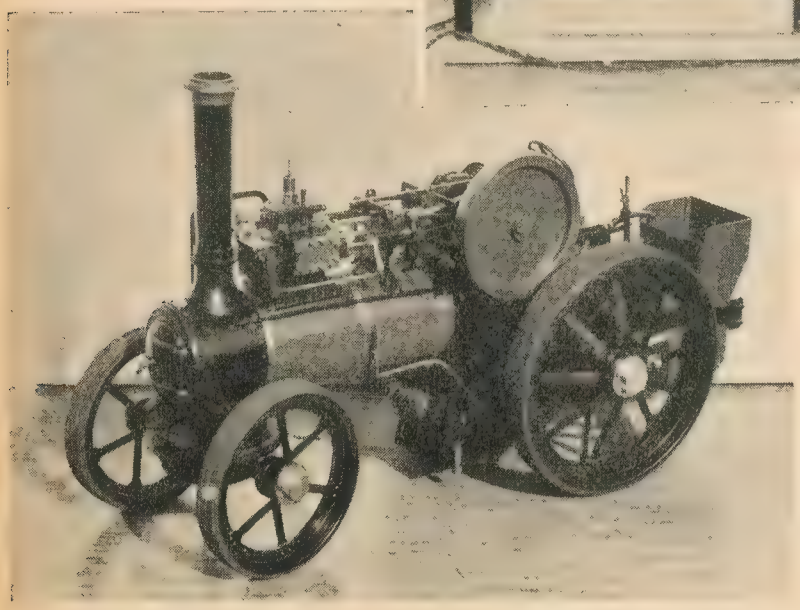
As might be expected in a town with a long railway history, steam had pride of place at their two-day show staged over the Easter week-end, in which locomotives, traction engines, stationary engines and steam-powered marine models predominated. The live steam section has recently completed 60 ft. of multiple gauge track, although to date none of the society's locomotives is steaming on it, and this year, brethren of the craft from the Bedford Society supplied the hauling power for the ever-popular children's rides. Visiting locomotives which worked this service were Mr. F. Palin's 2½-in. gauge *Marina* and his hard-working free-lance 3½-in. gauge 0-6-0 tank locomotive, Mr. R. Field's *Miss Ten to Eight* and Mr. W. Barnes's *Tich*. Passenger and driving cars were loaned by Mr. H. A. Taylor, and over 500 passengers were carried.

Mr. Taylor, director of a local engineering firm, also exhibited a handsome and beautifully finished L.M.S. "3F" in ¾ in. scale, a truly elegant example of locomotive modelling, displayed in a glass case and with its firebox realistically illuminated from within. In charming contrast to this was an exquisite 4 mm. version of the same prototype, running on the miniature railway section's track nearby. This lovely little engine was the work of the section's enthusiastic leader, Reg. Smith, and represented 18 months' spare-time work. A track extension and terminal station by the same builder augmented the section's regular layout, which was in continuous operation, with five locomotives and a Southern electric rail coach unit.

There was ample evidence that the new multiple track will soon be in demand by members. Two *Hielan Lassies* are coming along nicely, under construction by Messrs. J. Wallace and N. and W. Bailey, the former with tender and valve-gear completed, and the latter with boiler and firebox mounted. Mr. W. Barnes showed a very well built *Britannia* chassis, a duplicate of which is progressing side by side with it, "one for show and one for blow," as it were! Bro. Barnes's *Tich* is already demonstrating its considerable hauling power, although as yet unpainted, and amongst other uncompleted models were a 5-in. gauge *Butch* and a *Netta* by Mr. Field, a 2½-in. *Royal Scot* by Mr. V. Watson and a 2½-in. *Minx* by Mr. J. Missen. Visiting locomotives not in steam included a businesslike "3F" by Mr. W. Alderman and yet another *Tich* by Mr B. White, and the tale was completed by another good-looking 0-6-0 tank engine by Mr. J. Norton, built to the unusual gauge of 4¾ in. which performs very well when it can find a track to accommodate it!

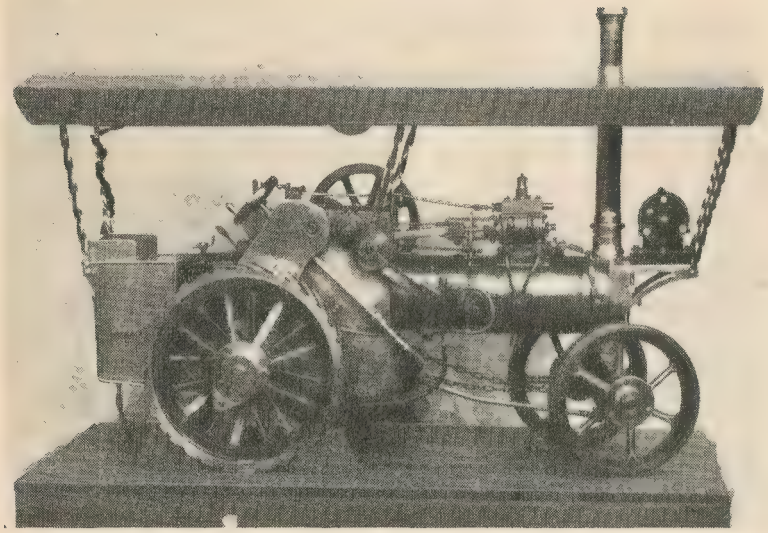


Mr. H. A. Taylor's good-looking ¾-in. scale 3F locomotive, shown in contrast with Mr. Reg. Smith's 4-mm. scale model of the same prototype



A 1¼-in. scale compound engine by Mr. W. Barnes, which combines excellent workmanship with an impressive performance.

Amongst the traction engines Mr. J. Wallace's example is a fine piece of work, and will be remembered as having been illustrated in Mr. W. J. Hughes's report of the 1953 "M.E." Exhibition. The versatile Mr. Barnes was represented here also, with a handsome 1¼ in. scale



A free-lance showman's engine built by Mr. V. Watson. Hand tools figured largely in its construction. Wheel rims are cast in brass, with milled strakes

compound engine which has a fine performance under steam, but which was ticking over peacefully on the air-line during the show. The Society's chairman Mr. E. S. Watson, showed a three-parts finished Burrell to 1-in. scale, which was notable for some pretty workmanship in the wheel department, and another interesting model was a free-lance showman's engine by Mr. V. Watson, built largely in brass and with hand tools, and employing much clever fabrication and sheer hard "hacking out" in its construction, even some of the gears having been cut by hand.

Two exhibits which attracted much attention from the younger element were the work of Mr. N. K. Peerless. The smaller of these simple little engines owed its existence largely to the scrap-box, utilising a discarded cylinder and piston-valve from an old Bassett-Lowke *Enterprise* amongst other oddments, and having convincing wheels built up from brass sheet and solder. Spirit-fired, this model steams energetically, and is soon to be joined by another simple but charming engine, based on a Fowler Big Lion *Supreme*. At the other end of the scale was an imposing 50-year-old model portable engine of about 2-in. scale, loaned by the president, Mr. J. E. Cave. This old engine, according to its engraved "maker's plate," was constructed by a Mr. Wise of Newport Pagnell, and has in its day earned its keep by driving a saw bench and pumping water to a local water tower. It ran sweetly on the air-line throughout the two days.

A variety of stationary steam engines of all types ranged from large horizontal mill-engines with vertical boilers to yet another effort by Bill Barnes, in the shape of a tiny opposed twin single-acting oscillating engine of $\frac{1}{8}$-in. bore and stroke. This engaging scrap of machinery was "knocked up in a couple of evenings to amuse the boys," and was tested by stroboscope to exceed 18,000 r.p.m. Its bee-like drone constantly fascinated visitors, though when we comforted the builder with the remark that the piston speed must be very low, he replied with a reminder that the crank-pin was a mere 3/64 in. diameter !

Petrol engines were represented by a nicely finished 30 c.c. o.h.v. single by Mr. J. Norton and a horizontal hopper-cooled motor of 15 c.c. entered by Mr. S. Tibbetts, and fairground enthusiasts were catered for by a small working model roundabout with authentic music supplied by gramophone, the work of Mr. Merrick.

Amongst the boats the standard of workmanship was somewhat lower than the rest of the exhibits, an outstanding exception being Bill Barnes's 53-in. salvage tug, a fine model nearing completion. This craft has a "bread and butter" hull of pleasing lines, nicely planked decking with butt-joints. Its power unit, a Stuart "Double Ten" with launch-type boiler with 22 cross-tubes, though not yet installed, was running happily in the engine section. The ever-popular diesel powered cabin cruisers were in the main kit models, several of which bore evidence of the builders' haste to see them in action, an exception being a pretty 4-ft. cruiser, *Stedfast*, fitted with a 5 c.c. petrol motor, and entered by Mr. K. McKenzie.

The society's aeromodelling section, which in previous years has had to rely largely on outside support, this year fielded a fine collection of its own work, outstanding amongst which were those shown by Section Leader D. Marsh, his diesel-powered Hawker Hind and large radio-controlled models being of particular merit.

In addition to viewing the models, over 1,000 visitors were also shown demonstrations of marking-out, track-work in 4 mm. scale, radar and G.P.O. automatic telephone working.

The hon. secretary of the Bletchley Society is Mr. S. C. Landford, of 36, Walnut Drive, Bletchley, Bucks.

A GEARBOX FOR A TWIN-SCREW BOAT

(*Continued from page* 496)

lubrication. The paste was made up by scraping an old oil-stone, mixing the resulting powder with thin grease and applying some of it to the gear teeth, care being taken to see that none was allowed to get on to the bearings.

After about half an hour's continuous run, the gears were dismantled, washed with petrol and dried, then reassembled, and a further run made, using metal polish on the teeth. It was noticed that this dried off too quickly, but when it did so, it was remoistened with a little grease and allowed to run for another half-hour. All this was done at a speed of about 100 r.p.m., to prevent the paste spraying off the wheels and getting into the bearings.

The gears were again dismantled for a thorough wash, as before, and on reassembling and lubricating with a suitable oil, it was found that they were free enough for the driving spindle to be twirled with the fingers.

Before commencing this unorthodox grinding-in operation, the bearings were, of course, properly lubricated with a light machine oil, as mentioned, but nevertheless cleaned and washed, as well as the whole gearcase each time the gears were cleaned, in case particles of the grinding paste had inadvertently found their way into the bearings.

Some say that it is wrong to use this method of finally shaping and smoothing the teeth, on account of the fact that it is possible for some of the particles of the abrasive material to become embedded in the brass teeth, which would cause excessive wear eventually. Whether true or not, it cannot be very serious with this rough work, because the gearbox, on inspection, appears good for many more years of hard work.

OPERATING PRINCIPLES OF THE GYROSCOPE

By R. N. Hadden

NEARLY everybody is familiar with the toy gyroscope and is aware that under certain circumstances it will behave in quite an extraordinary and unexpected way. Unfortunately, however, many people never go beyond this point, and try to find out the exact laws which govern gyroscopic motion. This is a pity, as a gyroscope can be made the basis for many ingenious and fascinating mechanisms.

Before going on to consider the practical effects of gyroscopic phenomena it is first of all essential to grasp how it will react to any given set of circumstances. This can best be done by referring to Fig. 1.

Suppose *OA*, *OB*, *OC*, are three lines at right-angles to each other (similar to the corner of a box). Now let a disc be made to spin with *OB* as its axis and let a twist be applied to the axis *OC* in the direction shown. A surprising thing now happens; the disc instead of moving in the direction of the twist, as would happen if the disc were stationary, moves as shown by the arrow in a horizontal plane towards *OC*. This phenomenon is known as precession.

If the direction of spin or twist is reversed, the direction of precession is reversed; if both spin and twist are reversed, then the direction of precession remains the same. Alternatively if the disc is caused to precess, then a twist is produced tending to oppose the precession.

The above explanation is perhaps a bit difficult to understand at first reading, but it will soon become clear if the behaviour of a model gyroscope can be observed. An alternative way to visualise the gyroscopic effect is to consider a bicycle. If the rider begins to fall, say to the right, then he must turn to the right, thus producing a gyroscopic twist on the wheels tending to turn him over to the left.

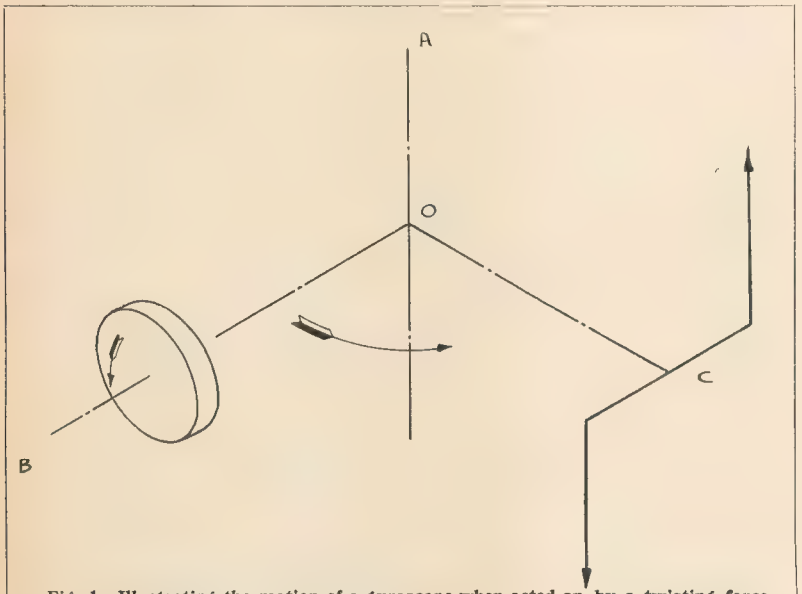


Fig. 1. Illustrating the motion of a gyroscope when acted on by a twisting force

Having decided how a gyroscope is going to behave when certain things are done to it, it is worth while having a look at what happens to a car while turning a corner. Each wheel and the engine are in fact gyroscopes, and as such will obey the laws already stated. In the car shown in Fig. 2 it is found that the gyroscopic effect on the wheels is to tip the car over to the outside of the curve (i.e., helping centrifugal force) and the effect of the engine is to tip up the front of the car. These effects increase with the square of the speed so that if the speed is doubled the "tipping" forces go up four times. In full-size cars this gyroscopic effect is not very great, as the car would tend to skid before sufficient speed could be attained to make the tipping forces very big. However, in the case of model cars moving at high speed in a tight turn on the end of a wire, the effects could be considerable. This is a point worth remembering when deciding the fixings for the wire on the car.

Car Springs

Independent springing for cars also produces gyroscopic effects if operated on the radius-arm principle. Referring to Fig. 3 the top view shows a car's wheels looking forward and the view underneath is the plan. If the car hits a bump the wheels move upwards as shown by arrows, thus rotating the wheels at right-angles to the axis. The effect of this is to produce a gryoscopic twist on the wheels tending to "toe" them inwards, as shown in the lower drawing. Of course, when the wheels move in the opposite direction the effect is the reverse, and so alternating stresses are set up in the track-rod as each bump is passed over. If there is any wear in the track-rod bearings or king-pins the wheels will alternately

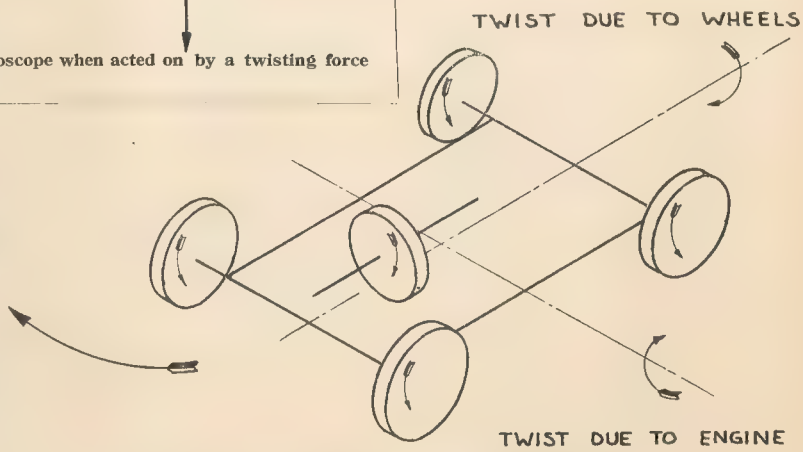
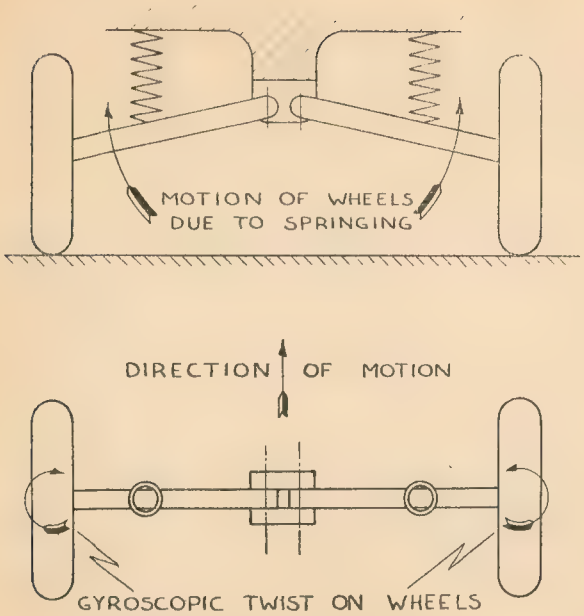


Fig. 2. A car turning a corner experiences gyroscopic twists due to the rotation of wheels and engine, as shown in this drawing



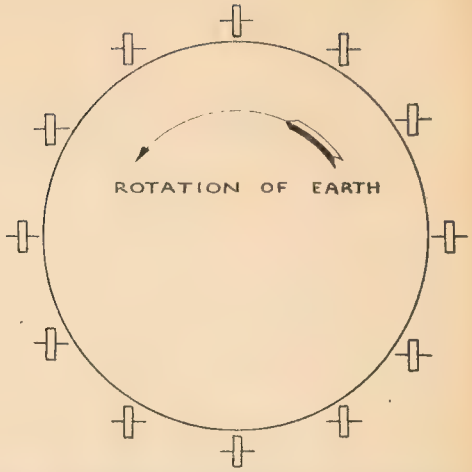


Fig. 4. Showing that rotation of the earth has no effect on the position of a freely mounted gyroscope

Left: Fig. 3. Showing how gyroscopic forces are produced in independent suspensions of certain types of cars

"toe" in and out, which is the perfect beginning for wheel wobble, and rapid tyre wear. For this reason, independent suspensions which keep the wheels vertical all the time have an advantage in this respect.

If the above principles have been understood, the method of gyroscopic ship stablisation should be quite clear. It consists simply of a large gyroscope mounted within the ship with its axis initially vertical. Now if the ship rolls to one side, a servo motor will tilt the gyroscope forwards or backwards so that a twisting force is applied to the whole ship in the opposite direction to the roll, thus keeping the ship on an even keel at all times.

The Gyro Compass

Another application of the gyroscope which is perhaps the most fascinating of all is the gyro compass. This, apart from its obvious use as a compass, is the basis from which automatic pilots, guided weapons, gun stabilisation in ships, etc., are constructed.

To understand the working of the gyro compass, consider first of all a plain gyroscope placed at the equator with its axis point East and West. Now if this gyroscope is mounted in gimbals it will be found to retain its initial direction in space as the earth revolves. Thus to an observer on the earth it appears to revolve in a vertical plane once every 24 hours. This is made quite clear in Fig. 4. If now, however, a tube containing a liquid is suspended underneath the axis as shown in Fig. 5, a new set of circumstances are created.

At position (1) the axis points East and West and the liquid is level in the tube. Now as the earth rotates the gyroscope tries to retain its initial direction, thus causing the liquid to flow into the left-hand limb producing the downward force *P* as shown at (2). This downward force in an axial plane causes the gyroscope to precess as shown at (3) until its axis points North and South as at (4). In this position the liquid is again level in the tube and there is no further force tending to make it precess. Thus the gyroscope is now stable and will remain pointing in this direction despite the rotation of the earth.

The above explanation is not the complete story of the gyro compass, as certain effects are produced as it moves towards the North or South. It will, however, give the general idea of its method of operation, and if any reader would like to make a further study of this instrument he should read *The Gyro-Compass and its Deviations*, by A. L. Rawlings.

To conclude, it is perhaps worth mentioning one rather remarkable machine built to make use of gyroscopic forces. This machine was a "two-wheeled car." The car was built in the early days of motoring for a Russian prince who wanted to drive around his estates on the very narrow tracks which then existed. He also desired that the car should remain upright even when stationary. For this reason it was built rather like a very large motor-cycle with a gyroscopic stabiliser in the middle. This gyroscope had to be kept running continuously except when the car was otherwise supported.

During its trials it was found to work satisfactorily but had a strange habit of slightly lifting whichever side was most heavily loaded. This was apparently due to the stabilising mechanism being rather over compensated.

The writer hopes that the above description of basic gyroscopic principles may prove interesting. If even one gyroscopic model is the result, he would feel his troubles well rewarded.

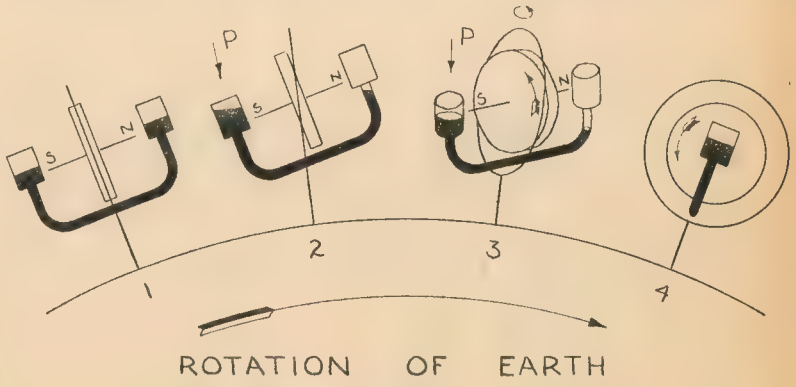


Fig. 5. Illustrating the operation of a gyro compass

L.B.S.C.'s "Netta"

SMOKEBOXES FOR THE 2½-in. AND 3½-in. GAUGE ENGINES

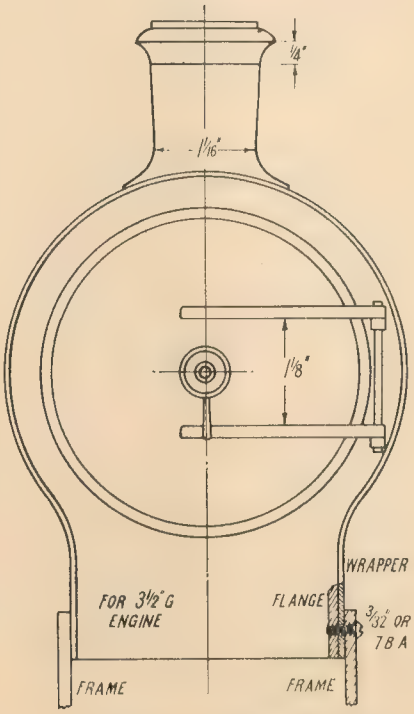
IN a further effort to make up for lost time, I'll deal with the smokeboxes for the 2½-in. and 3½-in. gauge engines together; but to avoid getting mixed up with the measurements, I have drawn them out separately. Also, to simplify matters, I have shown the smaller smokebox as a built-up proposition, needing no castings, and the larger job made up with a cast front, door, and back. As all dimensions are marked on the illustrations, I won't waste space by repeating them in these notes, except where necessary; nor will I use fifty words where five would do. First of all, may I point out that the construction shown for either size of smokebox can be used for the other; you can dispense with castings for the larger one if desired, or use a cast front and back for the smaller one, if available. For those builders who would prefer to have their locomotive look up-to-date and fashionable, I have included a drawing of a circular smokebox on a saddle; and as it is easier to make than the standard North Eastern type, you can bet your sweet life that that lazy person Curly would choose it, if I were building a *Netta* for myself. I might even fit a L.B. & S.C.R. chimney ! I already have a L.N.W.R. *Precursor* with a circular smokebox and stove-pipe chimney, and she looks —and *is*—a proper race-horse.

Built-up Type

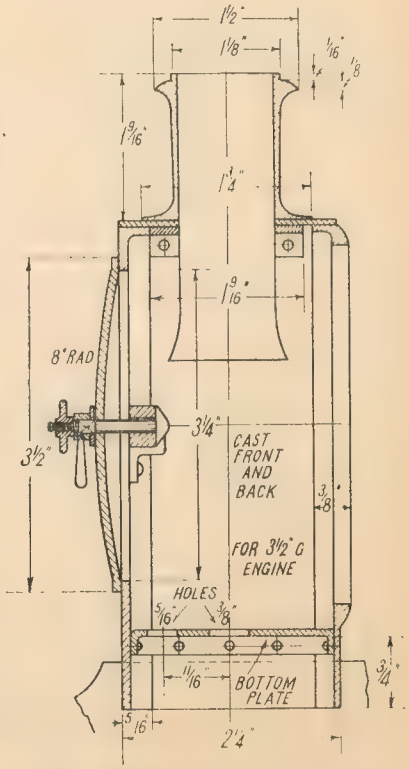
The built-up pattern consists of a circular barrel made from brass tube, around which is a wrapper sheet which can be made from either brass or steel sheet, as preferred. As the barrel is of greater diameter inside than the outside diameter of the boiler barrel, a ring will be needed, as shown in the drawing, and this can be made from a strip of metal bent into a circle that will fit inside the smokebox barrel, and silver-soldered. It should project a little way; and after silver-soldering, the barrel should be chucked in the three-jaw, ring outward, and the end of the barrel, and the projecting ring, rounded off as shown. This simulates the wide brass moulding around the joint between boiler and smokebox, in the full-size engines. Don't forget to put something in the end of the barrel before gripping it in the chuck; a wheel casting, or disc of metal or wood, or anything else that happens to be handy, and will prevent the chuck jaws distorting the barrel. If this isn't done, the barrel will fly out of the chuck, and might cause serious damage to the operator's personal anatomy. The other end of the barrel may be also squared off, while on the job.

For the 3½-in. gauge size, a piece of tube 4⅛ in. diameter and 2¼ in. long, would be needed; and the ring would need to be a full ⅛ in. thick. It should be bored to fit over the boiler barrel, in addition to being turned as mentioned above.

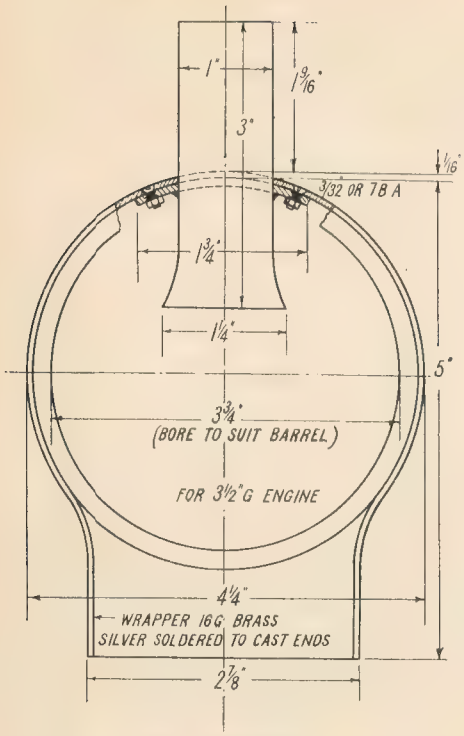
The wrapper sheet should be 18-gauge metal for the 2½-in. gauge job, and 16-gauge for the 3½-in. It is bent around the barrel, and secured by three or four screws (brass or steel, countersunk heads) at each side, just above the point at which the wrapper straightens out to go between the frames. At the back, it should be level with the turned ring; at the front, it should project 3/32 in. for the smaller size, and ⅛ in. for the larger. This will allow it to be filed flush with the front plate, after the latter is silver-soldered in. The front plate should be $\frac{1}{16}$ in. thick for 2½-in. gauge engine, and 3/32 in. for the 3½-in. gauge engine. It should be an exact fit in the projecting part of the wrapper —a nice little exercise in filing to a marked line—and should butt up against the end of the barrel.



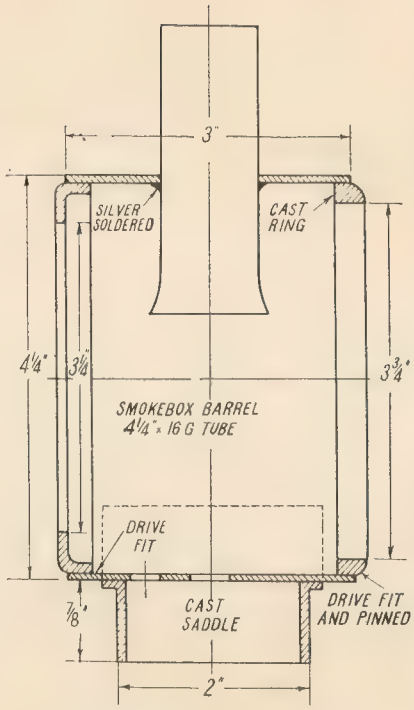
Front of smokebox, 3½-in. gauge engine



Section of smokebox, 3½-in. gauge engine



Back of smokebox



Section of alternative circular smokebox

Next, make the chimney liner from a piece of brass tube of the size shown in the drawing. The bottom end can be easily belled out if annealed, and a piece of metal, of the required shape, carefully driven into it; plumbers perform this antic when belling out the ends of lead pipes, but they use a boxwood drift. Tell it not in Gath, but when I want to bell the bottom of a chimney liner, I anneal it, and grip it in the three-jaw with the required amount projecting. I have a big pair of roundnose pliers, and I close the jaws, anoint the outside of them with a spot of grease, set the lathe running slowly, and force the plier-jaws into the end of the tube. In two wags of a dog's tail, the end of the tube bells out beautifully.

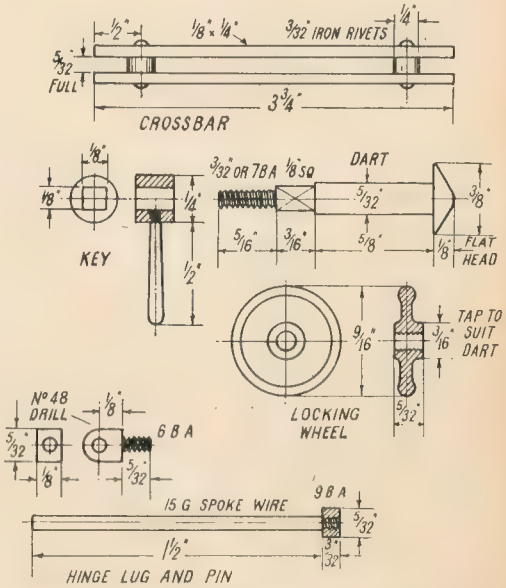
Cut the hole for the chimney liner, on top of the embryo smokebox, and be sure it is in the middle, so that the chimney won't be off-centre when seen from the front. The liner can be either just driven in, and silver-soldered when the rest of the job is done, or attached by silver-soldering it to a rectangular flange, which is then attached by screws to the inside of the smokebox. I've fully described that wheeze umpteen times already, and it is shown in the section and back view of the 3½-in. gauge smokebox given here. The final job is to fit a make-up or fill-in piece of metal, same thickness as front plate, and same shape as the bottom section of same, at the back of the smokebox, under the barrel and between the wrapper sides. The bottom part of the wrapper can be held to both front and back plates, by a little bit of ¼-in. × 1/16-in. angle, riveted at each corner. All that then remains is to silver-solder the whole bag of tricks at one heating, using best grade or Easyflo. Just smear a little wet flux over all the joints, and heat up the lot to dull red, applying the strip of silver-solder to each joint in turn. Don't be in too much hurry to quench out in the pickle-bath, or the plates will distort. Wash off and clean up, then file away any of the wrapper projecting, beyond the front plate, leaving the front perfectly smooth.

Smokebox with Cast Plates

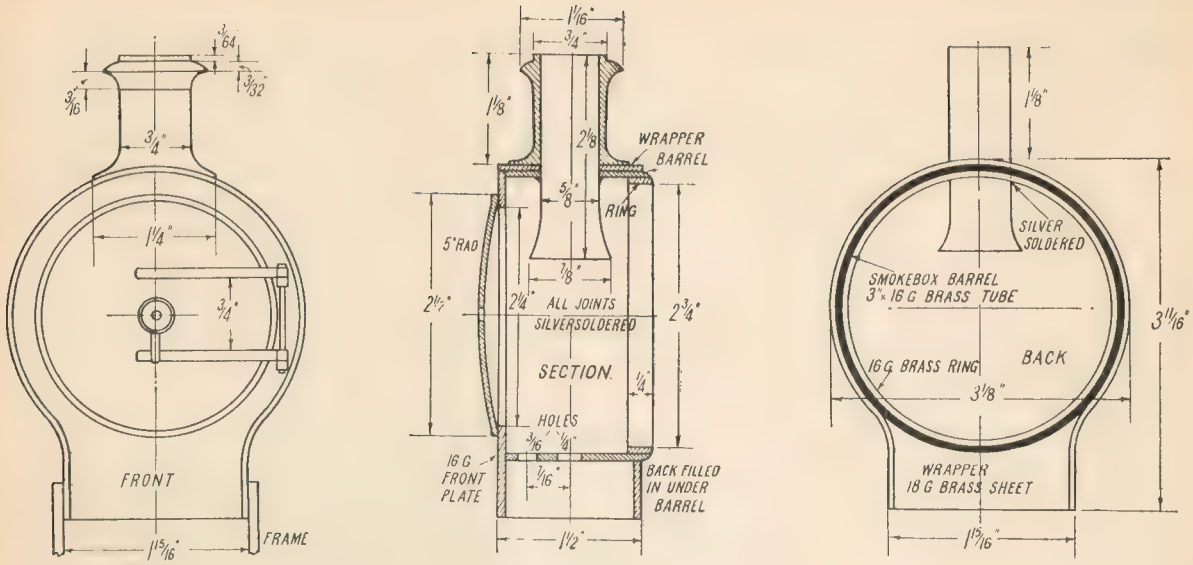
Two castings will be needed, one for the front plate, and one for the back; both are flanged as shown. The front plate has a flush front, with a hole in it a little less in diameter than the door; the back plate has a heavy bead cast on it, which is turned to represent the moulding mentioned above, and bored to take the boiler barrel. It is obvious that the flanges can't be turned to take the wrapper sheet, owing to their shape; so they will have to be carefully cleaned up with a file. The front plate can be chucked in the four-jaw, plain side outwards, and a cut taken right across it, with a round-nose tool set crosswise in the rest; this will ensure that the door, when faced, will close airtight. The back can also be chucked in the four-jaw, beading outwards, and running truly; first bore out the hole an exact fit for the boiler barrel, then turn the bead, and face off the part below it.

The wrapper should be of brass sheet, same thickness as given for the built-up smokeboxes; the width is shown on the drawings. Bend it to the shape shown in the front and back views, and attach it to the flanges of both front and back plates either by countersunk screws, or brass or copper rivets, at about ½ in. centres.

Cut the hole in the top, and make and fit a liner as described above, if it is desired to silver-solder it direct to the wrapper if the flange fitting is preferred, leave it until last. This smokebox needs a bottom plate, which is a piece of sheet brass, same thickness as the wrapper. Mark out a rectangle on the brass sheet, same size as the inner measure-



Smokebox door fastenings for the 3½-in. gauge engine



Built-up smokebox for the 2½-in. gauge engine

ments of the smokebox at bottom; then add another ¼ in. all around, for flanges. Snip out the corners, and bend them over, just like the lid of a mechanical lubricator tank; then fit the gadget in the bottom of the smokebox, in the position shown. The corners will have to be filed to clear the flanges of the casting. Fix the bottom with a few rivets, to prevent it slipping when the lot expands under the heat of the silver-soldering job. Incidentally, I've recently heard a really amusing tale about slipping and distortion, from somebody who tried to make up a boiler from unflanged plates.

The whole bag of tricks can then be silver-soldered, to seal the joints between wrapper, back and front plates, and bottom plate. For this job it would be best and safest to use either best-grade silver-solder, or Easyflo. Put some wet flux all around all the joints, and lay the smokebox on the coke in the brazing pan, back-plate upwards. No packing is required, and a small blowlamp will provide the heat needed. Heat the whole doings to dull red, then direct the flame through the big hole in the back, on to the joint between the wrapper and flange of the front plate. Apply the strip of silver-solder, and run in a little all around the flange. By doing this joint from the inside, the turned and faced front of the smokebox is kept clean; and as that is the bit which a lineside observer first sees as the engine approaches—nuff sed ! Run a little more silver-solder around the joint between back flange and wrapper, then do the bottom plate, standing the smokebox, bottom up, on the coke, and blowing direct on the flanges of the bottom plate. If the chimney liner is being silver-soldered direct into the wrapper, it can be done while the smokebox is lying down in the pan, as the silver-solder will flow all around it without any persuasion, directly the strip is applied. Pickle warily as mentioned above, then wash off and clean up as usual. The front should be rubbed on a sheet of fine emery-cloth, or similar abrasive, laid on some flat surface, to make certain that it is quite flat and true, otherwise the door will draw air, and the boiler won't steam.

Circular Smokebox

The modern type of circular smokebox has so often been described in these notes, that it would be sheer waste of space to go into full detail again. A section of one, suitable for the 3½-in. gauge engine, is shown here, and the drawing can be applied to the 2½-in. gauger as well, merely by altering the measurements to suit. The barrel should be 3⅛ in. diameter, and 2¼ in. long, in the smaller size, with a saddle 1¼ in. long. The front, in both sizes, can either be cast, or turned up from a ⅛-in. stamped brass blank, ½ in. bigger than finished diameter. This is annealed, flanged like a smokebox tubeplate, and turned up in precisely the same way, to a drive fit in the end of the barrel; the hole for the door is cut with a parting-tool set crosswise in the rest. The ring for the back, can be made from a slice of 3-in. × ⅛-in. brass tube, or a piece of ⅛-in. × ¼-in. brass rod can be softened and bent into a circle, to fit the barrel. Either can be silver-soldered in, then turned to simulate the beading previously mentioned, and bored for the boiler barrel. The chimney liner can be silver-soldered in direct, as shown, or attached by a rectangular flange. The saddle may be a casting, similar to those specified for *Tich, Juliet*, etc.; or built up from 1/16-in. or 3/32-in. sheet brass.

Door and Fittings

The door, in either size, may be cast, or knocked up from a brass blank, of diameter shown, and ⅛ in. thick. Cast doors will have the hinge straps cast on, so cannot be turned all over, and must be filed clean; incidentally, that was more than big sister's door ever needed ! However, the contact side needs facing truly around the edge, and this can be done by gripping the chucking piece provided on the convex side, in the three-jaw, and setting the door to run truly. Use a round-nose tool set crosswise in the rest. If a brass blank is used, dish it by softening first, then laying it on a block of lead and hitting with the ball end of a hammer. Chuck in three-jaw, holding by the edge, concave side out, face the projecting bit of edge, and centre and drill a No. 30 (or 21) hole in the middle. Face truly around the hole, for about ¾ in. diameter. Turn a pip on the end of a stub of brass rod about ½ in. diameter, to fit the hole; squeeze it in and solder it. Hold the stub in the three-jaw, and you can then face the whole of the front at one go, melting out the chucking-stub after finishing.

I have fully described, many times, how to make and fit hinges, lugs, crossbar, dart, and fastenings, and I expect builders will want to get their engines on the road before their great-grandchildren grow up, so repetition is superfluous ! Briefly, the crossbars are made from two bits of flat steel rod riveted together with distance-pieces between, as shown; same section can be used for both sizes. The brackets are bent up from 16-gauge steel strip. Hinge straps can be made from 16- or 18-gauge steel, or nickel-bronze, the end of each being bent into a loop and silver-soldered. If the eye fills up, as

(*Continued on page* 510)

An American "Atlantic" in South Africa

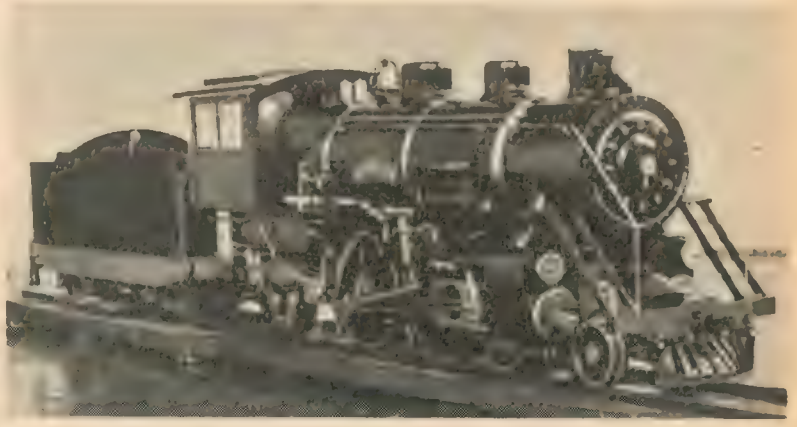
By J. McF. H. Scott (President, Cape Town S.M.E.E.)

SOME three years ago, I was attacked by the virus. I simply had to build a locomotive. A hunt round our local hobby shops revealed the fact that the only set of castings and prints available was for a Boston & Maine Atlantic in 3½-in. gauge, so a start was made.

Unfortunately for me, a lot of the detail work was left to the individual builder. This was O.K. for the chap on the spot, but not so good for me. However, as has happened so often in the past, our friend "L.B.S.C." (more power to his elbow !), in his weekly articles, helped me to iron out most of my problems. The others I had to find out by diligent research. The results you can see from the accompanying photographs.

The boiler was designed for saturated steam and had 31 × ⅜ in. tubes. I altered this and fitted 18 × ⅜ in. tubes and 4 × ¾ in. superheater flues. I fitted a 4-element superheater of "L.B.S.C." design. Having a smokebox regulator, it was possible to make the superheater grid removable. The smokebox front is so arranged that the whole thing comes out when the locking wheel is released. It is a very handy arrangement in that all the tubes, including the superheater flues, can be thoroughly cleaned out. Our coal has a very high ash content, and we find that, after running for, say, three hours, the lower tubes are choked. Having the large flues allows us to keep going.

Cylinders and steamchests are cast-iron. To ensure adequate lubrication and prevent rusting when not in use, a twin-cylinder lubricator ("L.B.S.C." *ex Live Steam Book*) with both rams ⅛ in. diameter is fitted. This is driven from the leading axle. The cylinder bore is 1⅜ in. diameter and stroke is 1¾ in. Slide-valves are fitted.



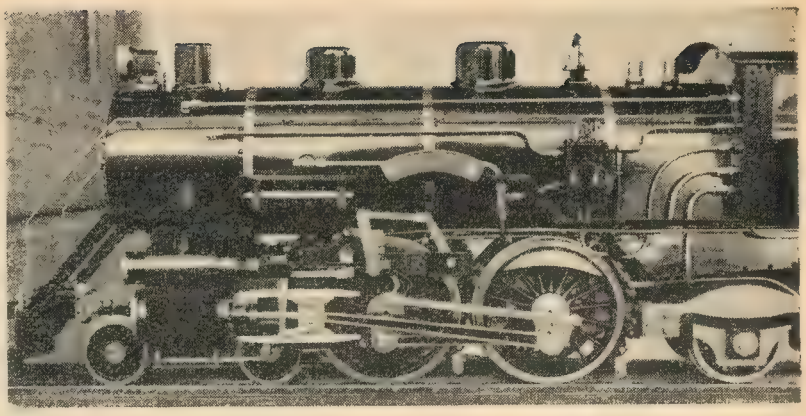
The valve-gear is Baker. Castings were used for the bell crank, reversing-yoke and gear connecting lever, also the gear frames. Reversing is by a "pole" lever on the right-hand side of the cab.

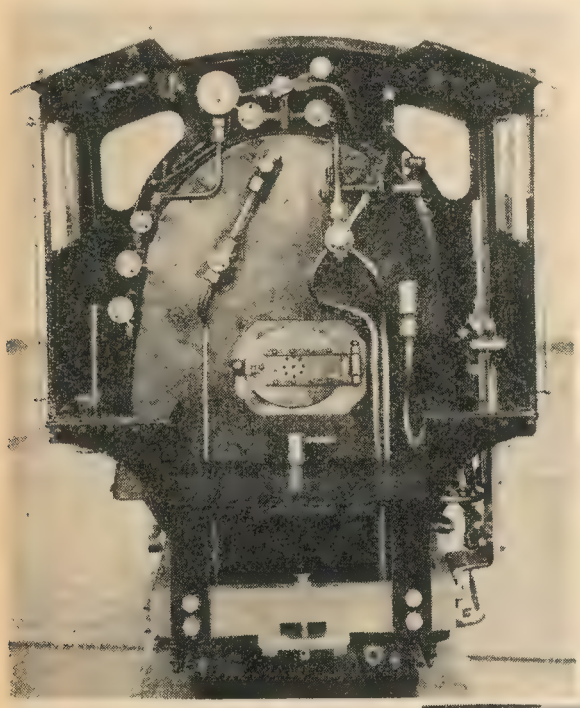
Steam brakes are fitted, operated by a valve in the cab. The cylinder drain-cocks, injector, and all the cab fittings are pure "L.B.S.C." The bell does ring, but its voice is so small that it is lost when running.

All footplates, steps, cab floors and rear platform of tender are made of miniature chequer-plate. This was rolled in a home-made mill and is

made of 17-gauge copper plate, painted black. It is most effective, and has received much favourable comment from judges at exhibitions when she has been shown.

Electric lights are fitted. There is the headlight, two cab lights, and a light over the filler of the tender. Two large air-tanks under the tender, house dry batteries, and plug-in leads connect these to the engine. There is a change-over switch in the cab. A turbo-alternator, similar to the one described by "L.B.S.C." some time ago, can be seen on the right-hand footplate. This works very well, and handles the four 2.5 volt lamps without any difficulty. The only time it gives trouble is when starting off. This is due to a surge of water in the boiler letting a dollop into the turret, and "stops the works" temporarily.





Near side view, showing the Baker valve gear and the duplex feed pump

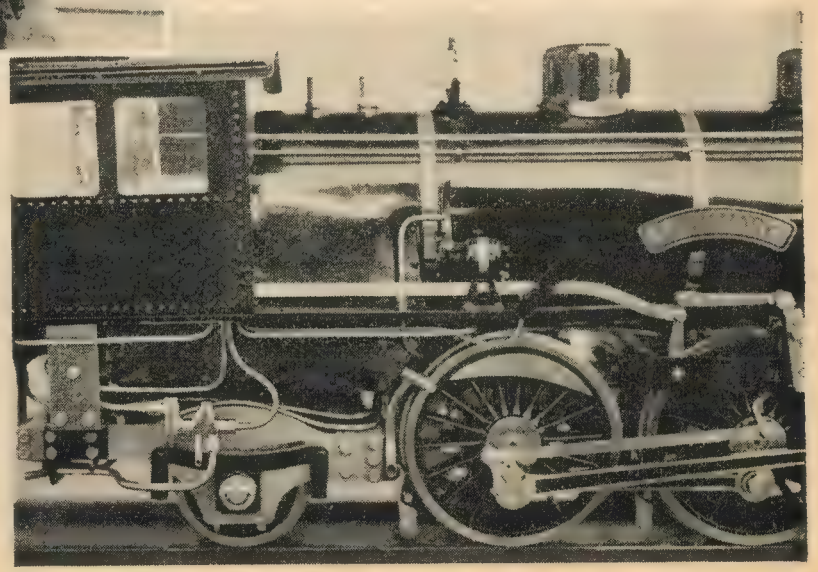
Left: Cab view. The arrangement of the fittings is neat and tidy

Below: Off-side view, showing the steam-driven turbo-generator

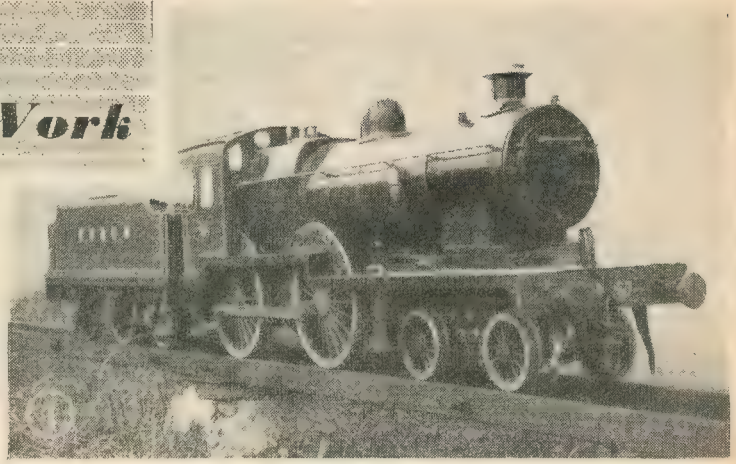
On the left-hand footplate there is an "L.B.S.C." duplex pump "lifted" from the *Live Steam Book*. In the prototype, there is an air compressor in this position. A dummy casting was supplied in the set; but, feeling that I wanted "something that works," I fitted the duplex in its place. It works very well, but is seldom used. Feed water is definitely not one of my problems. Twin axle pumps are fitted, having $\frac{7}{16}$ in. diameter rams with $\frac{5}{8}$ in. stroke. When standing, an injector takes over. There is a powerful twin-cylinder hand pump in the tender, but this has been used only for boiler testing so far.

I started off with the boiler pressure set at 100 p.s.i. It was found that she was too powerful and too inclined to slip at this pressure, and it was reduced to 90 p.s.i.

I am a member of two clubs. The Cape Town S.M.E.E. has a portable 100-ft. track, which is used at fêtes, etc. Last season it was estimated that *Lady Mary* had hauled approximately 20,000 paying passengers, and had earned a considerable sum of money for charity. The second club is the Cape Garden Railways, formed by a group of "Live Steam" enthusiasts. We have a 270 ft. continuous track built round the house of one of our members, Mr. Charles Pond. We meet as often as we can, and have a most enjoyable time. On this track, which is at ground level, *Lady Mary* has hauled three flat cars with eight grown-ups. She has the usual Atlantic trouble when starting with a heavy load, i.e., wheel slip; but, once under way, can keep going as long as the water and coal last.



Focus on Readers' Work



THE right kind of purposeful, rugged look is seen in *Cotswold Maid* (photo No. 1), built by Edgar J. Millington, of Cirencester.

The engine took 3½ years to complete and is fitted with superheater, steam brakes, mechanical lubricator, injector —L.B.S.C.'s design—and the usual water-gauge blowdown valve of the everlasting type, pressure-gauge, ring blower, whistle, etc. Valve-gear is Joy's with inside cylinders and mechanical feed pump driven from the rear axle of coupled wheels. The crankshaft was machined from the solid. Tender and engine are fitted with full brake-gear operated as per prototype.

Mr. Millington's track is 330 ft. round and has a viaduct for some 100 ft., it then runs into a cutting some 2 ft. 6 in. deep. There is also a gradient of 1 in 85. The track is laid with 1½ in. × ⅜ in. m.s. bars bolted together with spacers in the usual way.

Coupled with a live passenger load of five grown-ups, *Cotswold Maid* will lap the circuit, which is $\frac{1}{16}$ of a mile round, in 32 sec. She is an excellent steamer with immense power and, thinks Mr. Millington, a little too fast for the track. Mr. Millington applied to British Railways for a colour chart of the Southern locomotives, but could not obtain one. Consequently, he painted, lined and lettered the locomotive in the S.E. & C.R. livery, namely Brunswick green, black, chocolate, yellow lining and lettering and vermillion buffer beams.

Photo No. 2 illustrates a sterling example of the ever-popular "Seal" 15 c.c. four-in-line petrol engine—a well-known "M.E." design suitable for powering prototype boats. Enthusiast S. Newton of Chesterfield used cylinder liners of close-grained cast iron, crankshaft of nitriding steel (unhardened), flywheel of stainless steel, valves of chrome-vanadium alloy, and camshaft of nitriding steel (hardened). The photograph was taken with a Rolleiflex, and Proxar close-up lens, using a No. 1 Photoflood lamp 2 ft. away, and an exposure of one second at f. 16, on H.P.3 film. [NOTE: We appreciate these photographic details from contributors to this feature, when available.—ED.]

Technical details apart, we feel that the outstanding thing about the model shown in photo No. 3 is that with the exception of the flywheel, all machining was done on a wood-turning lathe with hand tools, by George Waines of North Queensland, Australia.

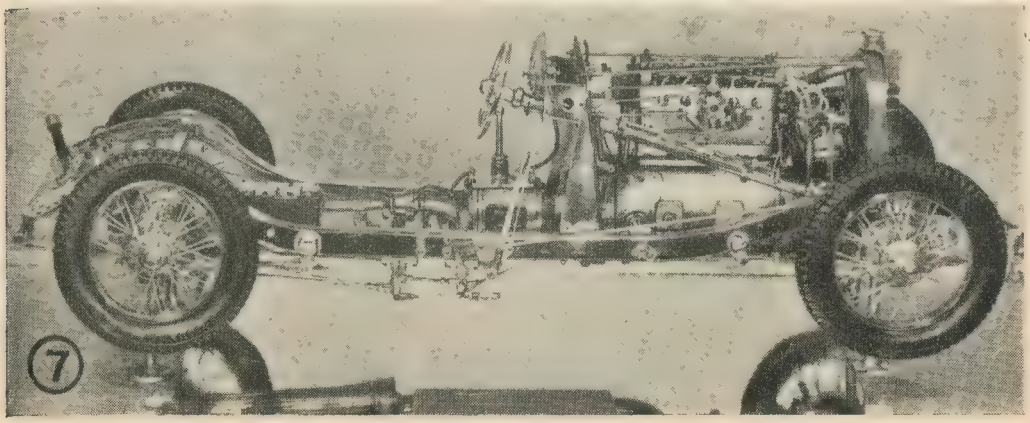
Herewith the technicalities:—Boiler barrel 3⅛ in. o.d. 13 g. brass tube; fire box and outer wrapper, 12 g. sheet brass; end plates cast brass ⅛ in.; five boiler tubes $\frac{7}{16}$ in. o.d. 18 g. brass, the job being assembled with rivets and screws and finally silver soldered.

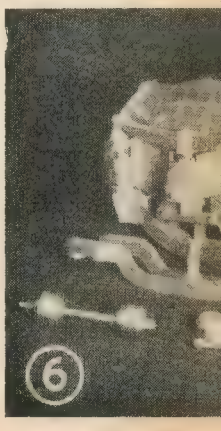
The five eccentrics were made with grooved sheave and tongued strap to save space and when fitting the Stephenson's reversing gear the extra two eccentrics were mounted on the bosses of the first two, a somewhat tricky job. A $\frac{5}{16}$ in. × ¾ in.-stroke double-throw built-up 90 deg. crankshaft, drives through a train of gears to ½ in.-pitch cycle chain on to 12-tooth sprockets, with band brake on rear wheels.

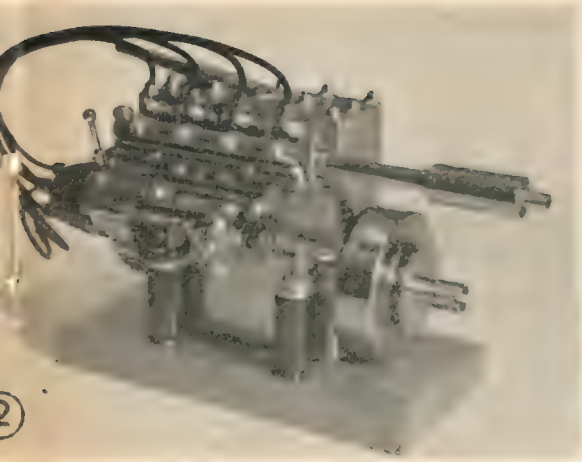
Incidentally, the small engine in the truck body is a ⅜-in. bore, crankshaft rotary-valve job which revs. at terrific speed with 40 lb. pressure.

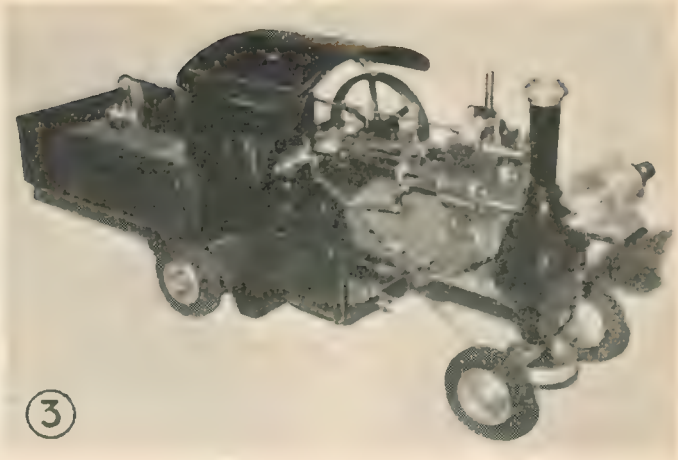
It is always refreshing to see unusual models such as that portrayed in photo No. 4. The subject is a part-sectioned caisson for a circulating water-pump house at Uskmouth Generating Station and the model was built by Messrs. L. A. Mitchell and P. Y. M. Duncan for their employers, Holloway Bros. (London) Ltd. The miniature girders—all of faithfully-reproduced section—were machined from solid brass in a Myford M.L.4. The 1,500 components of the model were all individually soft-soldered and over 600 ft. of material was used. The prototype is stated to be the largest caisson in the world.

No castings were used for the impressive freelance Hudson-type 4¾-in. gauge locomotive (photo No. 5) by H. Quick, of Pennsylvania, U.S.A.





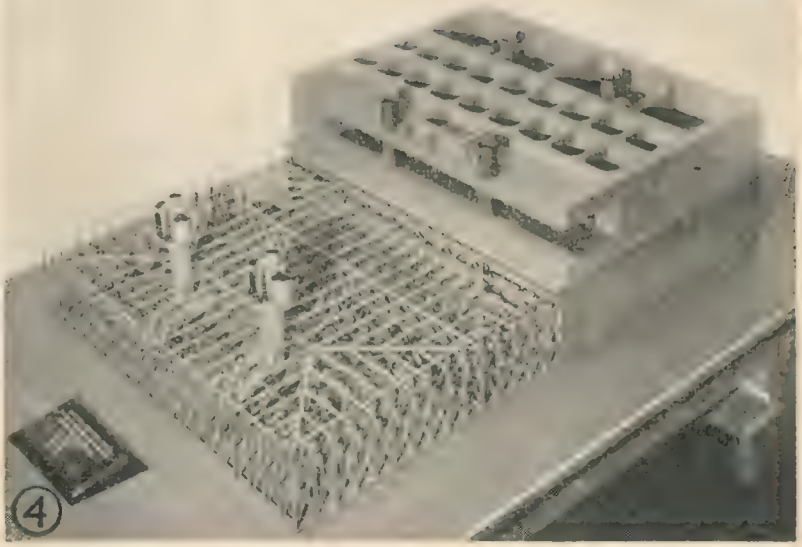


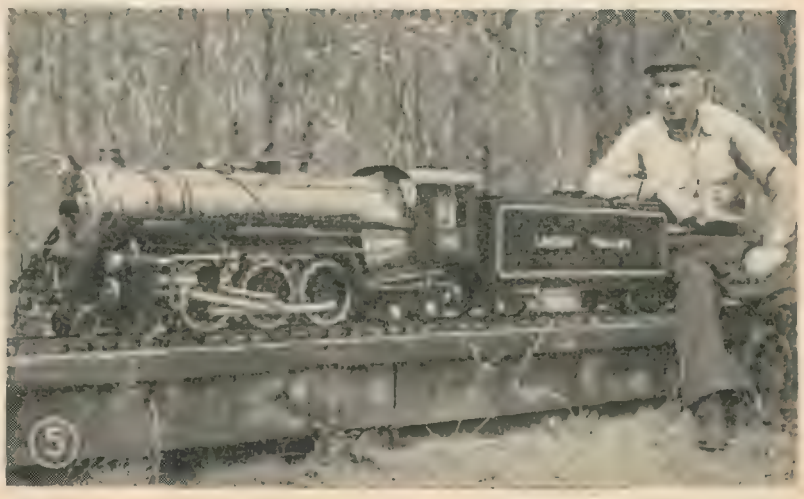


Wheels were cut from $\frac{7}{8}$-in. plate and cylinders fabricated and welded. Valve gear is Walschaerts, with $\frac{3}{4}$-in. stroke at 80 per cent. cut-off; working steam pressure is 180 lb. The 8-in. diameter boiler is of welded steel, with 26 fire tubes and three superheater flues having two units in each flue.

The top-rate workmanship featured in photo No. 6 comprises the bogie for a $\frac{3}{4}$-in. scale G.W.R. Dean 4-2-2 locomotive plus the four tie-bars and the central pin in the cross-bearers, by means of which the weight of the front end was transmitted to the bogie. This is the work of J. H. Balleny of Birmingham.

Readers may be spared the anguish of trying to identify the chassis seen in photo No. 7—for it is a freelance design, the work of Mr. J. Chapman of Louth. Work was spread over five years, and 3,000 " bits and pieces " went into the construction. Lovers of thoroughbred cars will appreciate the traditional design, with o.h.c. engine, laminated springs, central gear-change, etc. Inside the " beautiful but dumb " engine unit is the actual motive power—an electric motor—the reduction gearing being in the timing case.





A 10 c.c. General-purpose Four-stroke

TIMING GEARS AND FURTHER COMPONENT DETAILS

By

Edgar T. Westbury

BEFORE discussing the working parts of the timing mechanism, it may be as well to dispose of some of the more straightforward minor details. These include the crankcase breather and the oil feed union; the former, which is a necessary fitting for crankcase ventilation on all four-stroke engines, but of special importance in the case of single-cylinder engines for dealing with the air displaced by the piston, incorporates a simple non-return disc valve, and can also be used as an oil inlet or inspection aperture.

The object of fitting a non-return valve, which releases air freely on the down stroke of the piston, but prevents or at least restricts its entry on the return stroke, is to keep the mean crankcase pressure slightly below that of the atmosphere, and thereby assist the feeding of oil into the bearings, besides preventing leakage, and thereby promoting cleanliness of the exterior of the engine. It is not necessary that the release valve should be highly efficient, or that it should produce a perfect air seal when closed; I have used various types of valves for this purpose, but have come to the conclusion that a very light and relatively large disc valve, capable of extremely rapid action without noise, is most satisfactory. The position of the breather outlet is important, as it must not be in the path of oil spray which may be thrown up by the working parts, or it may cause considerable wastage, not to mention an untidy mess in the vicinity of the engine.

Continued from page 457, April 21, 1955.

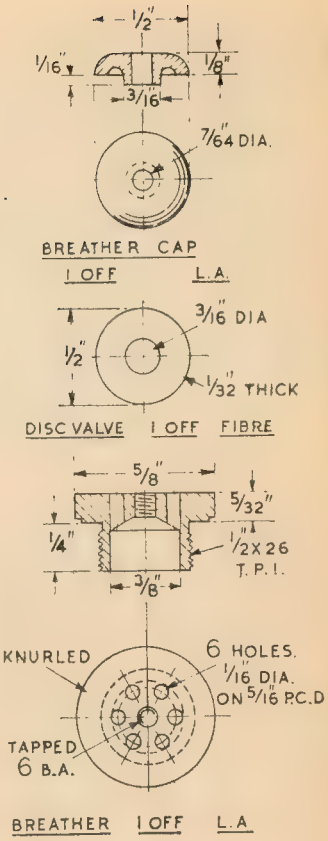
Breather Components

The main part of the breather is a screw cap with a knurled head, a circle of holes in the top face, and a tapped hole in the centre. It should be made of duralumin or other readily machinable light alloy and the machining operations are simple and straightforward, nearly all being capable of completion at one setting, including shouldering down and screwcutting, knurling, drilling and tapping, and counterboring. For facing the top surface, it may be held in a screwed bush in the chuck, or a slip of soft foil wrapped round the threads will protect them during this light operation.

The vent holes provide the sort of job that a drilling spindle can cope with accurately and efficiently, but if this is not available it will be quite in order to mark them out by such means as come to hand, centre-punch and drill them in the usual way, as accuracy of location is not important. They should, if anything, be pitched slightly inwards so as to run cleanly into the counterbore, and any burrs on the top face carefully removed.

An ordinary vulcanised fibre washer of suitable internal and external diameter may be used for the valve, alternative materials being thin bakelite, paxolin, presspahn or similar non-metallic substances; a metal disc is liable to be noisy. It must of course be quite flat and free from burrs; if cut out from sheet, it is best to use a hollow punch to produce the centre hole, and shear roughly to outside shape, then sandwich one or more discs between metal washers on a screwed mandrel, and turn to finished size.

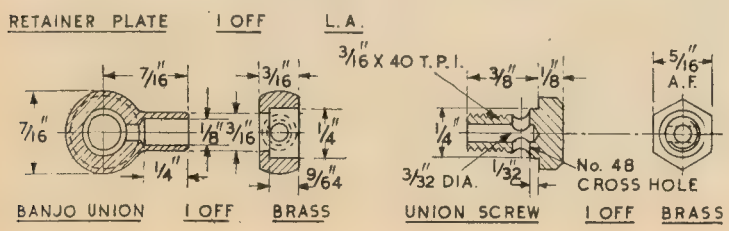
The cap should be made with a spigot to fit loosely in the hole in the valve, and the rim faced back so as to allow the disc to lift about 1/32 in. This part also can be turned at one setting from a piece of light alloy rod, except for cleaning up the top surface, for which operation it may be held lightly in the chuck by the spigot. The cap is held down by a 6 B.A. stud or set screw, with a shakeproof washer under the nut or the head.



Oil Feed Union

The banjo union shown will generally be found most suitable for connecting up the oil feed, whether this is by means of suction, drip, external pressure system or mechanical oil pump. A straight union, projecting radially from the boss of the bearing housing, will usually result in too much room being taken up by the complete fitting, even with the sharpest possible pipe bend, or an elbow close up to the union. Although the discharge efficiency of a banjo union is low in relation to its size, it is ample to deal with the small quantity of oil required by the engine under maximum demand conditions.

To machine the union, a piece of brass rod $\frac{7}{16}$ in. diameter can be used if chucked as truly as possible; otherwise use oversize rod and rough it down externally, drill and counterbore, but limit the depth of hole so that it does not intersect the crosshole when



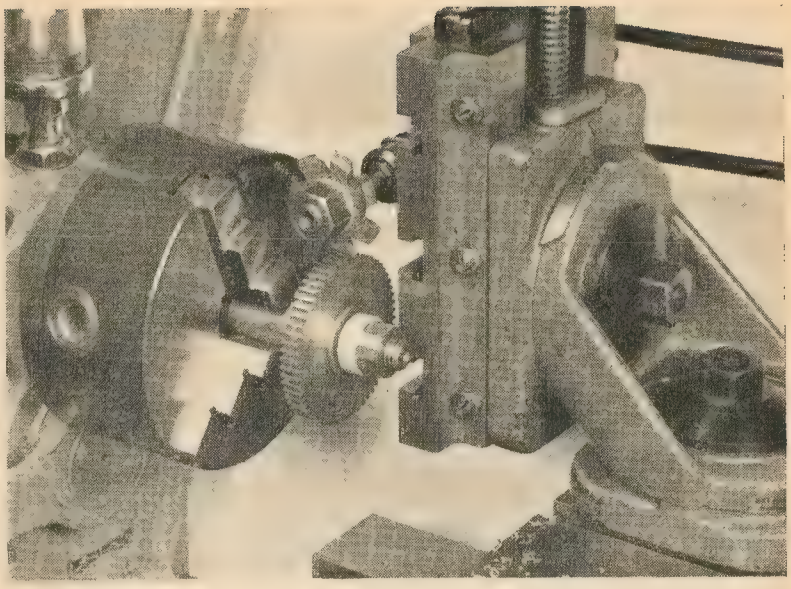
the latter is drilled later. The neck and the adjacent part of the spherical curve can be turned to finished size, after which the part is cut off and held by the neck for completing the ball, either by the use of a simple ball turning tool or by hand tools. Exact accuracy of the contour is not important but any serious error will show up badly when the flat sides are machined, so a little care in getting it right is justified.

The ball may now be held crosswise in the chuck, with the neck projecting between two of the jaws, and its axis parallel with the chuck face. It can then be centre-drilled, faced, drilled and counterbored. The back face can be machined by mounting on a plug held in the chuck. It will be seen at this stage why it is not desirable to drill the axial hole too deeply, as the presence of this hole would throw the drill out of truth in the subsequent operation, and produce an inaccurate (and probably leaky) union. But don't forget to finish drilling the axial hole before putting the job into service !

I have made a slight modification in the design of this union since the first drawings were made. It is usual for this type of union to have either a chambered recess in the centre of the cross bore, or a groove in the union screw, to prevent the passage being blanked off or restricted when the crossholes are out of line. In a very small union, however, both courses are undesirable; in the first case through machining difficulties, and the second, risk of weakening the screw. I have, therefore, produced the same effective result by counterboring the union and stepping the diameter of the screw to register in the counterbore.

The screw is quite a simple job, made from hexagonal brass bar about $\frac{5}{16}$ in. across flats (or nearest available size), and can be turned on essential surfaces, screwed and drilled at one setting; take care to get a clean machined joint face under the head. Drill the cross hole to line up as close as possible with the centre of the union.

This is rather a lengthy description for a very simple component, but banjo unions are used on very many kinds of small machinery, and I have seen some very unsightly—not to mention inefficient or unsatisfactory—samples at various times, so a little general instruction on the subject may not be out of place.



Cutting the spur gear by means of a milling spindle mounted on the vertical-slide

Retainer Plate

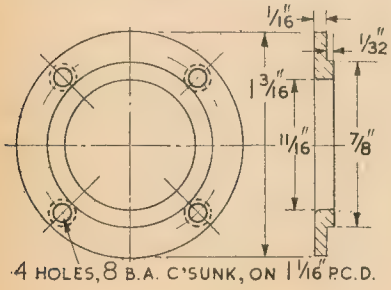
The object of this component is to locate the inner (fixed) main bearing race, the outer one, as already stated, being allowed slight latitude endwise, to deal with possible assembly error or differential expansion of the parts. Many constructors may consider this fitting unnecessary if the race is made a tight fit in the housing, and I have omitted it in some previous designs—and have been severely censured by many orthodox engineers, who point out that a retaining device of some kind is insisted upon in assemblies of this kind in all high-class designs. There is no doubt that, even if it does nothing else, the plate clamps the race against possible creepage, which might in time wear the housing and produce all the symptoms of a slack bearing.

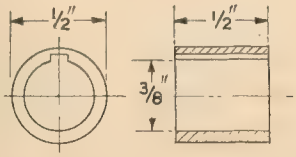
It might also be considered that the retainer would be better fitted to the inner or crank disc side of the housing, as this would allow of the entire crankshaft assembly to be inserted or withdrawn from the engine as a unit (less flywheel, of course), but in this case the plate would be more difficult to assemble, as access to the fixing screw could only be obtained through the lightening holes in the crank disc. However, in this, as in many other details, constructors can satisfy their own preferences or prejudices.

The plate may be made of duralumin, though steel or brass are also permissible, and no special precision in any of its dimensions are called for, so long as the spigot enters the bore of the housing freely, and the faces are adjusted so that it bears on the ball-race before making contact with the housing face, but without excessive clearance at the latter point. After drilling and countersinking the screw holes, the plate may be used as a jig for the tapping holes in the housing, which are not shown in the crankcase detail drawings. When the race and the plate are finally assembled, and the screws tightened, they may be prevented from possible slackening by centre-punching the plate adjacent to the screw slots, so as to throw up burrs which will enter the ends of the slots and deter movement. "*C'est brutal, mais ça marche* !"

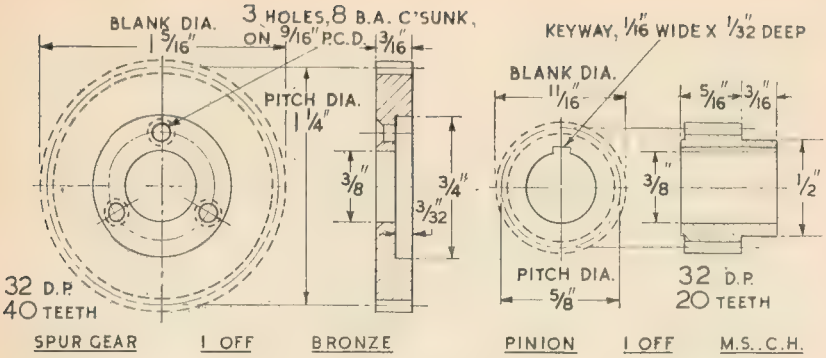
Spacer Bush

This component takes up the space between the timing pinion and the inner ball-race, so that the crankshaft assembly can be clamped up endwise. It calls for no special precision, except that the end faces must be true and parallel, and its length may possibly have to be adjusted slightly to obtain the proper location of the outer ball-race in the housing of the timing end-plate. As it has no drive to transmit, the necessity for an internal keyway may be questioned; but the fact is that this part is an auxiliary which may be interchanged for a worm in the event of a mechanical oil-pump being fitted either initially or at a later stage. As I feel sure that the advantages of the





SPACER BUSH 1 OFF M.S.



oil pump will be appreciated, sooner or later, by many users of the engine, and that they will not be keen on the job of extending the keyway in the shaft, I recommend cutting a long keyway at the start and keying the sleeve in position.

Timing Gears

I am hoping to be able to arrange for the supply of suitable gears for this engine, but it is not easy to do so under present conditions, as most firms with equipment for gear cutting appear to think in astronomical production figures, and are not very interested in such small orders as may be anticipated to cope with the requirements of amateur constructors. Gears *can* be obtained—at a price !—so I trust that constructors will not suspect profiteering if they are found to cost a good deal more than the odd gears which can be found in a bin outside the local "surplus" shop. Incidentally, I am always out to save expense to constructors, and have explored all available sources of supply of ready-made stock gears, but without satisfactory results.

The timing gears selected are of 20 and 40 teeth respectively, which in the appropriate diameters employed, works out at 32 diametral pitch. It may be observed that the minimum diameter of the pinion is determined, in this particular design of engine, by the necessity to mount it directly on the crankshaft, which in the interests of strength and rigidity, I have not considered prudent to reduce to less than ⅜ in. diameter; consequently the gear come out larger than is usual in small engines. This is not a bad fault, as it gives plenty of room for sturdy timing mechanism, and lowers the pitch line loading of the gears, as compared with smaller gears doing the same work. From experimental tests, I am satisfied that the gears will stand up well to the job, and work efficiently if accurately cut.

The pinion is of mild steel, and may with advantage be case hardened if this can be done without risk of distortion, but it is not essential, except perhaps for the most severe conditions of working on high-performance engines.

While on the subject of case-hardening, I note that this matter has been discussed in the correspondence columns of THE MODEL ENGINEER, and the importance of exact carbon content of "mild" steel has been stressed. I make no claim to a profound knowledge of metallurgy, and I have no wish to cast doubts on the correctness of the advice given, but I do think that the risks and difficulties have been rather over-stressed. In the course of many years, I have done odd case-hardening jobs on steels of known and unknown origin, *not* always with the precise results desired, but I am in a position to state that all grades of mild-steel I have encountered, including free-cutting grades, will case-harden by the "open-hearth" or cyanide process (usually the only method available to amateurs) more or less successfully, though the tendency to distortion varies greatly.

I have yet to find a steel sold or specified as "mild" steel which will harden right out merely by quenching from a red heat; and if we go round insisting on knowing the exact carbon percentage in every bit of steel we buy, I do not think it will ease the headaches of our long-suffering traders very much ! Many of them are doing a very conscientious job in trying to meet our manifold, various and unusual requirements, and they often have to take material offered without asking questions about its chemistry or ancestral origin.

The large spur wheel is specified as made in bronze, but I have been trying out a duralumin wheel with successful results. It will be noted that this gear has no boss, but is arranged to bolt to a flange on the camshaft. This is by no means uncommon practice, but in case it should be questioned there are definite reasons for its adoption here. In the first place, a boss would take up end room which can ill be spared on the camshaft, and, secondly, its absence enables the gears to be produced more cheaply, as a stack of flat blanks can be mounted on a mandrel and cut at one operation. Some of the commercially-made gears have pressed-in bosses, as I have found to my sorrow when I have used them for heavy duty and afterwards wondered where the mysterious slip was coming from !

A Boring Method

It is essential, when necessary boring and recessing operations are done on a finished gearwheel, to mount it truly, and the method I employ is to bore out a thin bush in the chuck to take the gear a push fit, leaving both external and internal shoulders to ensure face location, and then grip the wheel over the teeth by tightening the chuck so as to distort the bush. This assumes that the teeth have been cut concentrically with the outside of the blank, but, if not, it would be a complicated matter to correct the error in any case.

Those readers who wish to cut their own gears will find plenty of information on the subject in past volumes of THE MODEL ENGINEER and also in the handbook "Gears and Gear Cutting." It is by no means a formidable job to produce satisfactory spur gears in small sizes, either by milling or planing methods, and I have very little sympathy with the model engineer who shrinks from tackling the construction of an engine because he is afraid of "the hand bits." Successful model engineering depends entirely in the resolute facing of problems, and the determination never to let any job get you down.

(To be continued)

L.B.S.C.'s "Netta"

(Continued from page 503)

it probably will, just poke a drill through it, same size as the hole in the lug. The lugs are turned from flat rod chucked truly in four-jaw, and are screwed into the smokebox front. Some folk prefer to turn their darts from steel rod of the same diameter as the head, filing the latter flat after turning; but I make mine from rod of same diameter as the stem, and braze on a flat head filed from sheet or strip. The key is a slice of steel rod with a handle screwed into it as shown; drill the hole first, to given diameter, and file or punch it square, to fit the square on dart. The handwheel is turned from round rod, like a valve-wheel; either steel or dural can be used. The hinge pin is a bit of spoke wire, with a blob screwed on the end, as shown.

QUERIES AND REPLIES

"The M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with:

(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

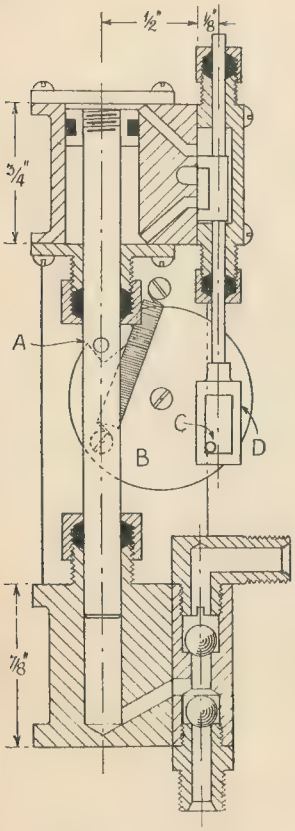
Direct-acting Foot Pumps

I am constructing a "Gurney" type water-tube boiler as described in the THE MODEL ENGINEER *and am looking for a design for a foot pump, preferably of the vertical single-cylinder type with a fairly simple valve-gear. Any assistance you can give in obtaining a sketch or a detailed drawing of such a pump will be greatly appreciated.*

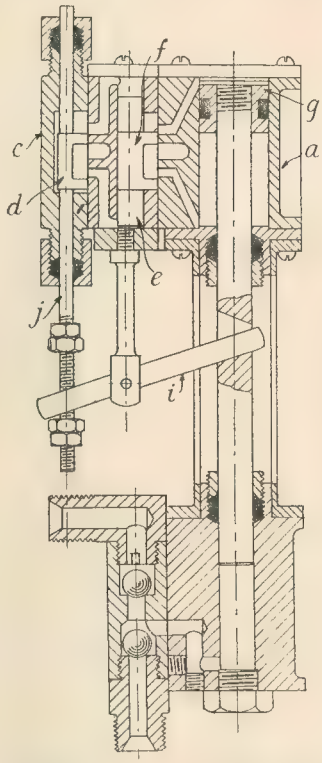
T. S. (Birkenhead).

The simplest examples of direct-acting steam pumps we know are those which were described in THE MODEL ENGINEER by "L.B.S.C." some years ago.

In the first example, the valve motion is operated by a trip-gear device in which a spring is operated to complete the full motion of the valve after it has once been started by the motion of the piston-rod.



Section of donkey pump.



Section of Weir type donkey pump.

It will be noted that a pin *A* on the rod engages in a notch in the disc *B* to which the spring is anchored and at the end of its stroke causes it to move the anchorage point of the spring beyond its dead centre, so that it flies over, and a pin *C* in the disc moves the valve-rod by means of a bridle *D*. The same action in the reverse direction takes place at the other end of the stroke.

In the second pump, a servo action similar in principle to that of the Weir and other well-known pumps is applied. The subsidiary slide-valve *d* is operated directly from the pump piston-rod by a lever *i* and controls the admission of steam to a piston valve *f* controlling the main ports.

A full description of the first type of pump appeared in the issue of THE MODEL ENGINEER dated June 15th, 1933 and the second in the issue dated June 29th, 1933.

Reversing Switch

Can you please inform me where to buy a reversing switch suitable for 1/3 h.p. a.c. motor, such as used for driving a small lathe or other machine tools? I have been unable to obtain a suitable switch from the makers of the motor.

W.C.I. (Gatehouse-of-Fleet).

Reversing switches suitable for motors of 1/3 h.p. can be obtained from most manufacturers of switch gear.

A type of switch suitable for workshop motors generally is that manufactured by Messrs. Dewhurst & Partner Ltd., Inverness Works, Hounslow.

Steam Engines for Beginners

My son, aged 13, wishes to learn model engineering, and as I have a workshop with the usual equipment, I propose to obtain a set of castings and parts for a simple model steam engine, on which he can make a start. Can you suggest a suitable set which can be obtained complete with detailed blueprints?

R.N. (King's Lynn).

Several firms advertising in THE MODEL ENGINEER can supply sets of castings and parts for building simple model steam engines. We can recommend the Stuart Turner engines, and, in particular, the No. 10 horizontal or the No. 10 vertical, which are well suited to construction by a beginner.

We can supply detailed drawings of several other types of simple steam engines, and castings for their construction can be obtained from our advertisers.

Next Week . . .

A MODEL JOWETT JAVELIN

This article describes the construction of a true scale chassis model of a popular type of car, including a working "flat four" engine.

COOLANT SUPPLY

How to construct a simple and efficient coolant system for machine tools, with suds pump, tray and filter.

LATHE HEADSTOCK INDEXING

An American reader will describe a useful attachment for indexing and rotary feed, for use in milling operations in the lathe.

CONCENTRIC DRILLING

Practical instruction on an important basic lathe operation which often presents difficulties for the beginner, by "Duplex."

AIDING THE DESIGNER

An informative article giving examples of the many ways in which models can help designers of familiar objects.

Motorising the Cabinet Workshop

By C. R. Jones

A GOOD many readers of THE MODEL ENGINEER may remember the cabinet workshop I described in the issues of January 15th and 22nd, 1948, and also the photographs which illustrated the article.

I have an outdoor workshop, which houses a Myford M.L.7 and other tools, but I find this indoor cabinet workshop invaluable.

It was made during the winter of 1946, and since then has enabled me to do a lot of work, which otherwise would have been impossible owing to various conditions, weather not being the least of them.

Readers who recollect the article will remember that normally it has a flat top, and (with a small amount of imagination) looks like an ordinary piece of furniture; but, when in action, a flanged lid can be removed, and a 3 in. screwcutting lathe be raised into working position; several drawers are provided at the right end to accommodate various tools, and two doors close in the front to the left.

The cabinet is not fixed to the building in any way, and the feet stand on hard rubber blocks.

At the left-hand front corner, a thick steel plate is let into the top, having various tapped holes, enabling a vice to be fixed in a few moments, as well as other tools.

With the vice in position it provides a small fitting shop.

Photograph No. 1 shows the cabinet as it normally is, although the various light reflections in the picture make it look a bit rough.

A 3-ply shield has been fitted at the rear and right-hand end to keep the walls clean, and on this, at the top and about two-thirds along, are fitted a few electric sockets for use with electric soldering irons, etc., also there are two small nests of drawers for fine tools, as well as an angle-poise bench lamp (not shown). On the wall above the bench, a gas fitting has been left in place, which provides gas for a Bunsen burner, and for three gas blowpipes of different sizes, used for soft soldering, and small silver-soldering jobs.

On top of the bench to the left can be seen the handle which is used to raise and lower the lathe, as was described in the previous article (see photograph No. 1).

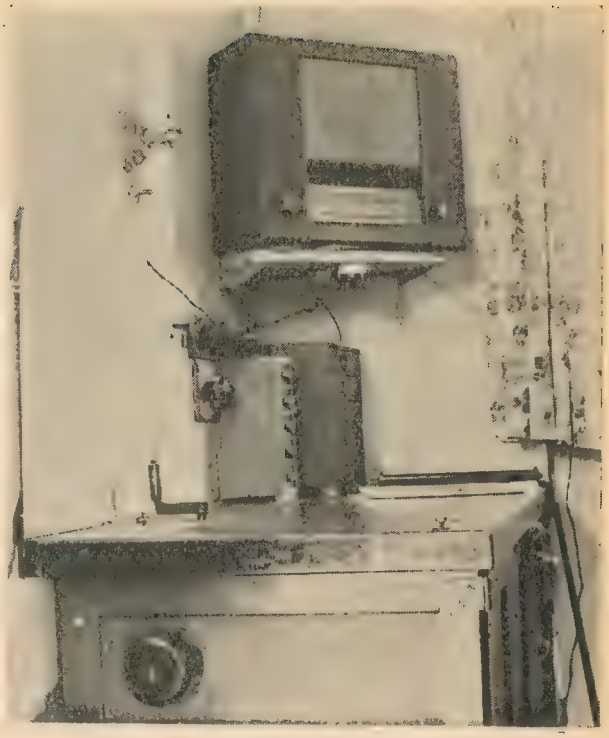
At the time the cabinet workshop was constructed, no electricity was available, and, as described, a ball-bearing foot-motor was made, which was used to drive the lathe up to the time when the mains were installed in the house.

When electricity became available, it was decided to use a ¼ h.p. electric motor to drive the lathe, instead of foot-power, but on thinking the matter over, this proved not to be such an easy matter as at first appeared.

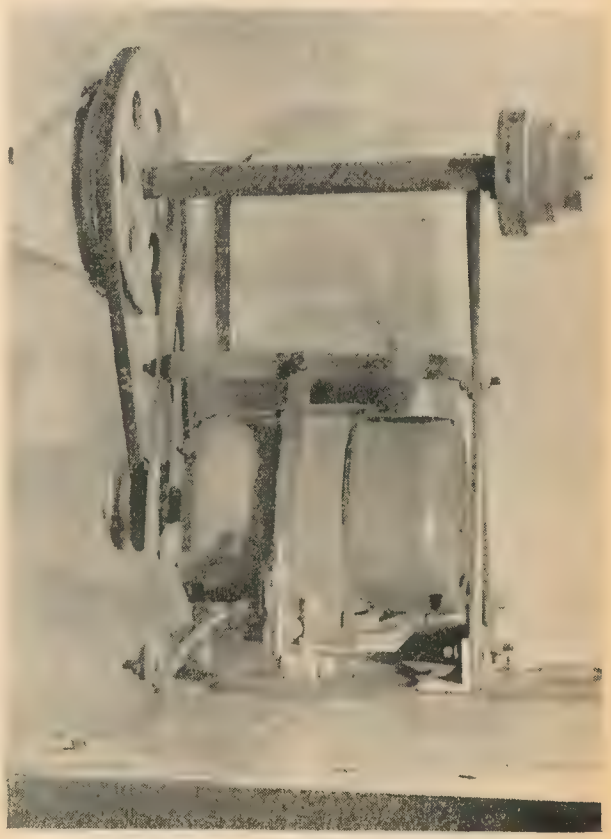
I originally had ideas of mounting the motor underneath the lathe, and to be raised up with it, but this involved some sort of reduction gear, as well as the fact that using a matching pulley to drive the headstock, some sort of jockey pulley arrangement would have to be used to enable the belt to clear the leadscrew, etc.

After considerable thought, various measurements, sketches, etc., this idea was abandoned, and it was decided to make up a self-contained motor countershaft unit, to fit on top of the bench at the left rear, for power purposes.

This is shown in photograph No. 2 and consisted of a triangulated frame made up from 1-in. × ¼-in. flat mild-



Photograph No. 1. View of workshop when not in use



Photograph No. 2. View showing the original drive

steel, bolted at the bottom to an angle-iron frame having three sides, and at the top to a tube having bronze bushes at each end.

Two short pieces of 1-in. × ¼-in. flat steel were welded on to this tube, and were bolted to the apex of the flat iron frame. This allowed a certain amount of adjustment to the belt driving the lathe, to be made.

The shaft was a length of ⅝ in. diameter bright mild-steel and the pulley and wheels were held on to this by means of grub-screws, the shaft having flats to accommodate them at either end.

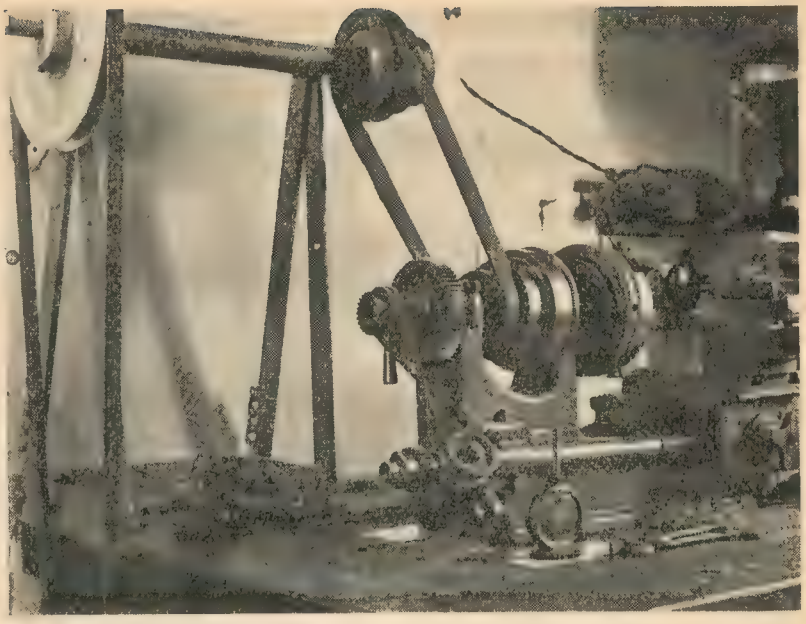
A ¼ h.p. Higgs motor was purchased; this was mounted on a platform underneath the countershaft, and was hinged on a long bolt which went through the two back members (the hinge working on rubber bushes). The three alternative positions can be seen in photographs Nos. 3, 4 and 5.

The motor was placed on a piece of Sorbo rubber, also entirely surrounded with Sorbo, and retained by a wide clip.

An arrangement was fitted at the front for adjustment of the motor belt, without it being necessary to alter the tension of the lathe belt. This adjustment was also fitted with a rubber bush.

This motor countershaft was fitted to the top of the bench by means of two simple clips, it only being necessary to tighten two nuts to hold it securely.

This unit worked perfectly, and was exceptionally quiet, which was all to the good; also, besides driving the lathe, it enabled me to use various other small machine tools, and for some time had quite a bit of use.



Photograph No. 3. Showing the lathe raised up in working position

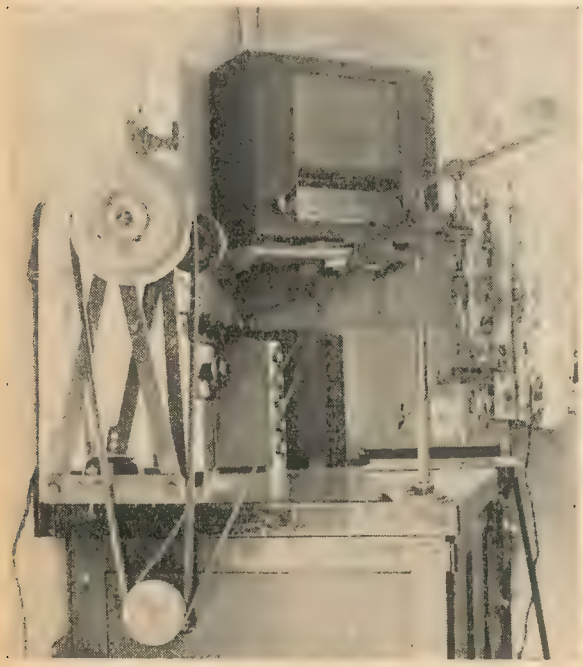
After some use I discovered several snags: one was that it was quite heavy to get out and lift on the bench every time it was required to use the lathe, grinder, drill, or what have you, and I am afraid I was inclined to make use of a hand-drill or hand-grinder rather than hump the motor about, when the lathe would not be used as well.

Eventually I decided that this had got to stop, so the drive was again altered.

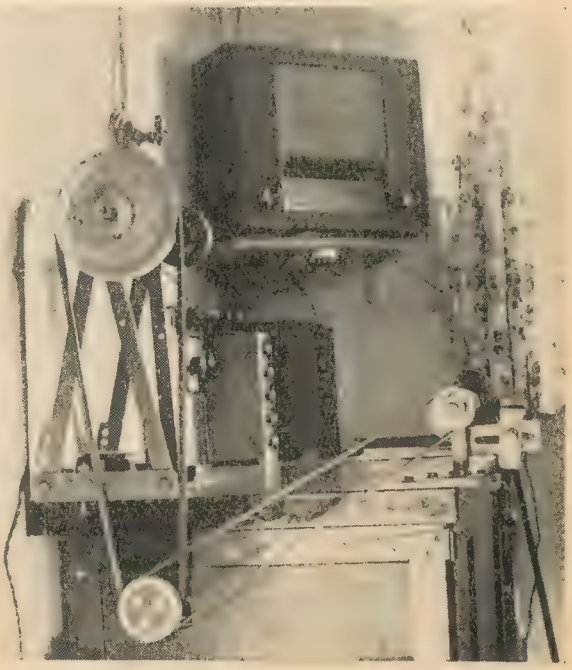
The motor was removed from the countershaft unit, and mounted inside the cabinet underneath the lathe lifting-gear, still retaining the long bolt, and its rubber-bushed hinging arrangement.

It was fixed with the motor pulley close up to the left panel of the cabinet,

(*Continued on next page*)



Photograph No. 4. The sensitive drill being driven



Photograph No. 5. The small grinder being driven

EARTHING ELECTRICAL INSTALLATIONS

By J. W. Cooper

THE risks appertaining to bad or inefficient earthing of electrical installations cannot be too strongly stressed; many instances where lack of proper precautions have caused loss of life and fires may be quoted. The earth wire, therefore, becomes a really important part of any electrical installation. With an all-insulated system, such as an all-rubber wired job with all insulated fittings, earthing cannot be carried out for obvious reasons; what I wish to stress here is that the covering of the respective fittings cannot be earthed, but any apparatus held in the hand is protected by the earth wire that would form part of the actual wiring.

The earth wire provided in any installation is for a definite purpose, and this is to give protection against leakage of current to earth due to a fault or other cause. In quite a number of cases, leakage currents are not due to faults at all. There is an effect that is known as surface leakage; this means that not due to any fault in the apparatus, current can leak to earth through natural causes. This effect is present in a number of articles, such as domestic irons, kettles, vacuum cleaners, toasters and other apparatus. Surface leakage can also be caused by a number of conditions, including moisture, which acts as a conductor, dust, poor or unsuitable insulation materials. With an iron or kettle, at the initial heating, sweating is likely to take place inside an iron, or in the connector housing of a kettle; while this moisture is present, a leakage will take place, not necessarily sufficient to blow the circuit fuse, but of sufficient value to give an appreciable shock to earth should the apparatus not be earthed. A test taken under these conditions would show the article to be unsafe for use; though normally, and as the article heats up, this moisture will dry out, when a perfect and safe reading will show. Leakage currents like those just described are not necessarily dangerous, but they could be with a person perhaps suffering with any form of heart trouble. From this it will be seen that where proper earthing is carried out, such a happening would be impossible.

There are regulations governing the earthing of electrical installations in buildings, and these regulations state that no earth wire may be less in size than 7-029, this size being considered sufficient for the normal installation. Where larger earth currents are likely to occur, the earthing is dealt with by providing a suitable size of conductor to suit the immediate conditions. In any case, an earth conductor should not be less than one half the size of the largest cable feeding the apparatus to be protected.

The actual earthing of an earth conductor is also important; where the supply company provided the earth position, all earth connections should be made to this position. The earthing to a water pipe is permissible, but only if a connection can be made to the mains side of this supply. It is not permissible to make earth connections to a secondary water system, that is to say, a hot water pipe or similar piping, and a gas pipe would be barred for obvious reasons.

The writer would like to quote two actual instances of inefficient earthing and their dangers. In the first case in point, shocks were being received from a pair of hair clippers in a hair-dresser's shop; inspection showed that the apparatus was earthed, as was the switch-plug feeding. it. The earth wire had been properly attached, but unfortunately, just to the waste pipe from the wash basin; this, of course, would never be connected to earth in the accepted sense. The second case was detected by a smell of burning rubber when a certain motor was running; here it was found that the earth wire was just a piece of ordinary 3/.029 V.I.R. cable, which had been run a considerable distance to reach the company's earth position. It was found that the fuse feeding this particular motor was about three times the size of the earth wire. The fault current was of such value that, in view of the resistance of the length of the earth wire, it caused it to reach a sufficiently high temperature to scorch the rubber covering; it was proved that, had this motor been allowed to run for any length of time, the rubber covering of the cable would have caught fire. In one more instance, the writer actually saw an earth wire at a dull red heat in a building; in this case the earth wire was found to be ordinary soft iron, 18-s.w.g., and its resistance, with the current flowing through the fault, was sufficient to allow it to reach this temperature.

MOTORISING THE CABINET WORKSHOP

(*Continued from previous page*)

allowing for a short countershaft, running on two ball-bearings, to be fixed on an angle-iron support, with one end of the countershaft protruding through the panel, as shown by the photographs, near to the top, and to the rear.

This short countershaft was driven by a "V" belt from the 2 in. pulley on the motor, to a pulley 3 in. in diameter, on the inside end.

Adjustment of this belt was still provided for, and none of these fittings interfered with the lifting or descent of the lathe.

The countershaft spindle was $\frac{5}{8}$ in. in diameter, and the ends were provided with flats, so that various pulleys of this bore could be used, and secured with grub- or Allen-screws.

With the motor speed being 1,425, the countershaft appears to run at a speed of 950, the controlling switch being situated on the front of the cabinet.

The original countershaft—now denuded of the motor—was again used on the rear corner of the bench to drive the lathe, using a long "V" belt to drive it from a $2\frac{1}{2}$-in. pulley fixed to the short countershaft (see photograph No. 3).

When not in use—and with the pulley removed—the short end of the shaft is covered with a metal cover (see photograph No. 1).

The sensitive drill, grinder, and also a small disc sander (all home-made), are driven by round leather belts from the small countershaft (see photographs Nos. 4 and 5).

All the above tools are fixed to the corner plate by means of one $\frac{5}{16}$-in. Whitworth set-screw, and washer; they are fitted at their bases to mild-steel plates $\frac{3}{16}$ in. in thickness, which, being slotted, allow for belt adjustment.

I find this method of fixture very convenient and quick, and as they are only used for light work, this method of fixing is all that is necessary.

Although it will be noticed that the larger countershaft is on the bench in Photographs Nos. 4 and 5, this is not necessary if it is not wanted to use the lathe.

Except when using the lathe, it is only necessary to remove the metal cap, fix a suitable pulley to the protruding spindle, and drive the other tools by means of the round belt.

I have found that this, the latest conversion, has been a boon, and a great time and labour saver, the countershaft now being very light, and easy to lift about. This, and the small machine tools, now store underneath where originally the footmotor was.

For new readers, the size of the cabinet is: height 37 in., length 4 ft. and width 2 ft.

IN THE WORKSHOP BY DUPLEX

An Independent Traversing Drive

THE large change wheel carried on the end of the leadscrew of the Myford 4-in. lathe is cast with four holes in the web, and these provide an engagement for the peg fitted to the driving arm *H* which is secured to the main spindle of the attachment. The change wheels of the M.L.7 lathe, however, have solid webs, and the driven arm *J*, attached to the end of the leadscrew, is therefore formed with a forked end to engage with the driving arm *H*. As can be seen in the sectional drawing, reproduced in the previous article, this arrangement also enables the driving arm to clear the intermediate wheel of the compound train that provides the normal automatic traverse for the saddle of the M.L.7. The intermediate wheel in the gear train of the attachment is mounted on the arm *B* by means of the stud *K*, and the latter is furnished with the bushing *L* for carrying the gear wheel, which is retained by a collar and nut.

The Motor Mounting

The motor used in this instance is a Magslip, running at 3,000 r.p.m. when supplied with current at 50 V from a mains transformer, and it is fitted with the type of footed mounting referred to in a recent article, describing a drive for a back toolpost drilling attachment. This arrangement enables the motor to be readily removed and used for either purpose. As can be seen in the accompanying photograph, the motor foot-plate is bolted to a baseplate *M* for attachment to the bracket *N*, and the latter is in turn secured to the arm *P*, which is bolted to the gear cover by means of the two shouldered studs *Q*. These studs ride in long slots formed in the arm, in order to provide for adjusting the alignment of the driving belt when the gear ratio of the wheel train is altered.

The $\frac{1}{4}$ in. V-belt is numbered No. 401, and was obtained from Messrs. Mountain of 307, Borough High Street, London, S.E.1.

The rather shallow section of this type of belt makes for flexibility, and enables it to grip well on the small motor pulley fitted.

(*Continued on page* 518)

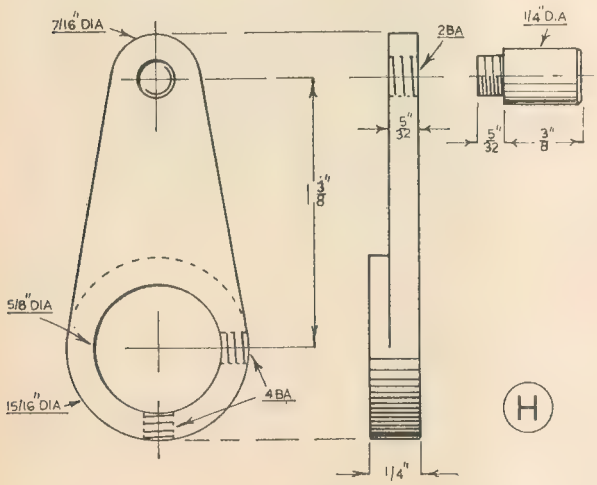


Fig. 11. The driving arm fitted to the main spindle

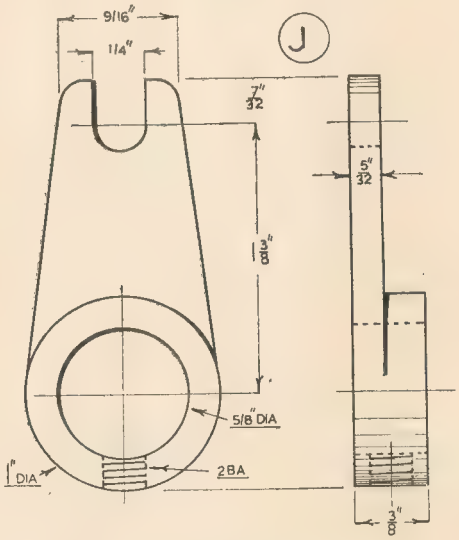


Fig. 12. The driven arm attached to the leadscrew of the M.L.7 lathe

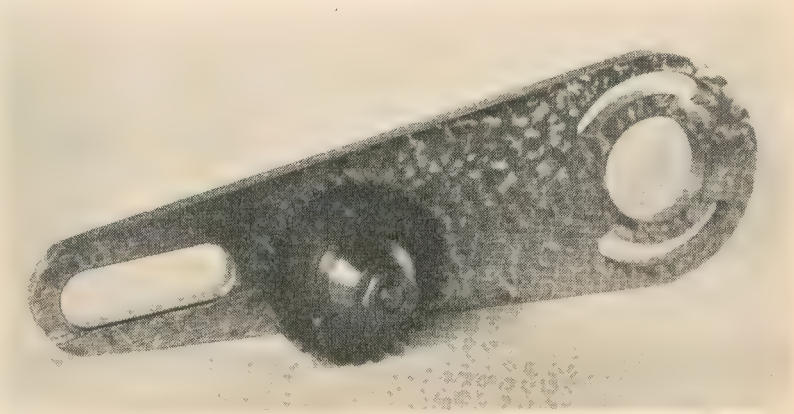


Fig. 13. The arm—B—with the intermediate gear wheel mounted on the stud—K

(*Continued from page* 444, *April* 21, 1955)

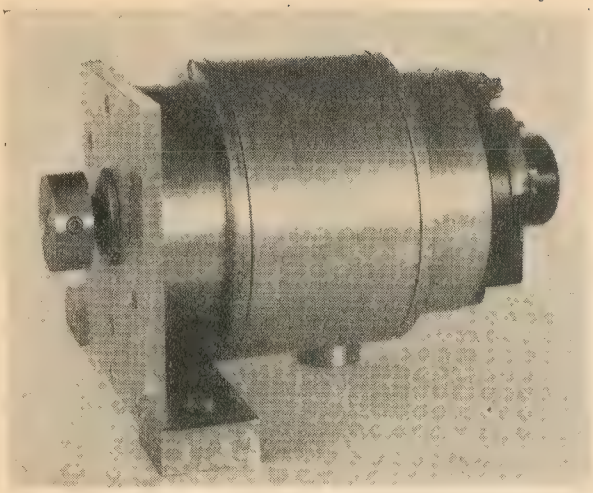


Fig. 14. The Magslip motor with its permanent mounting

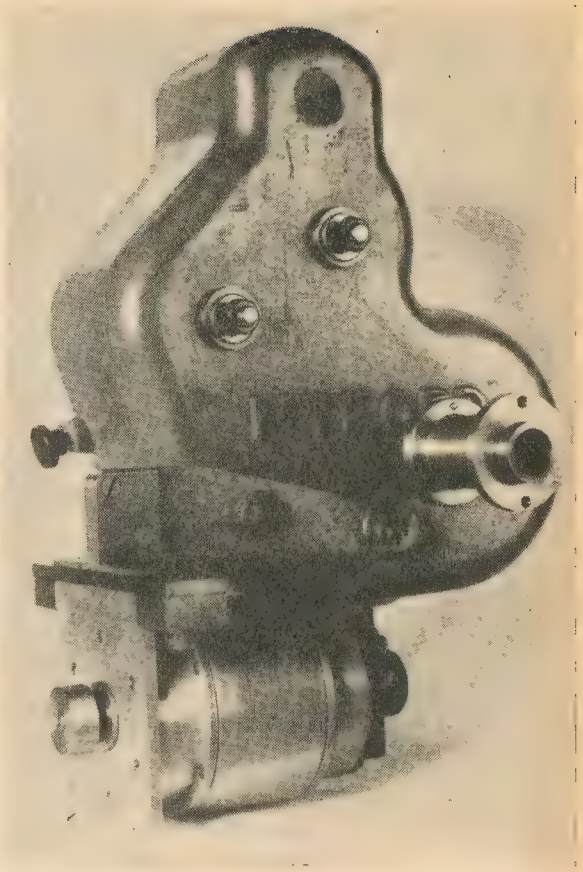


Fig. 15. Showing the arrangement for mounting the motor on the gear cover

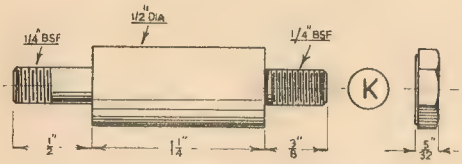


Fig. 16. The intermediate wheel stud

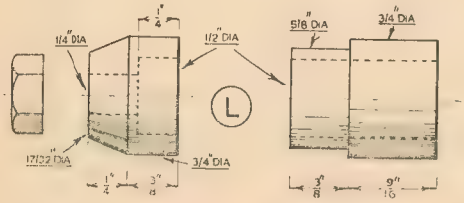


Fig. 17. The intermediate wheel bushing and retaining collar

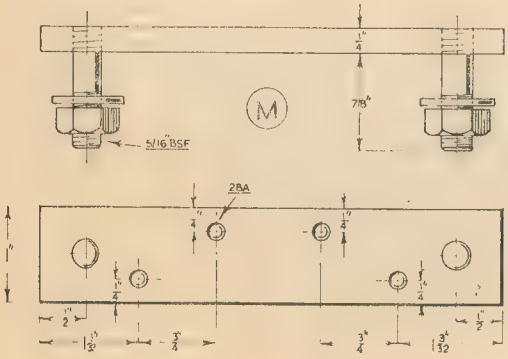


Fig. 18. The baseplate of the motor bracket mounting

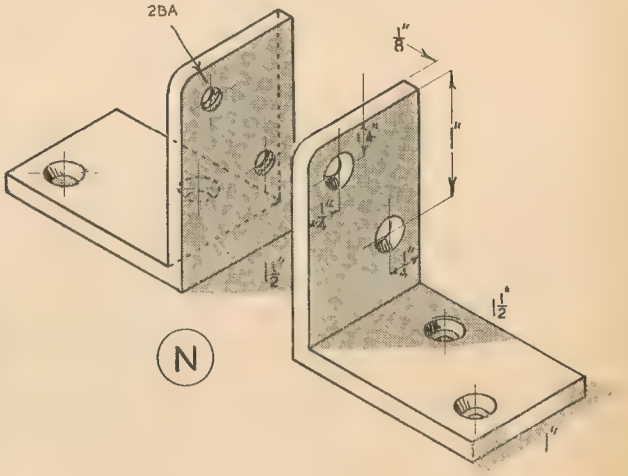


Fig. 19. The two angle-plates forming the motor bracket

READERS' LETTERS

Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.

BENT-CRANK GAS ENGINES

DEAR SIR,—I am deeply grateful to Mr. Backhouse and others who have replied to my enquiry about bent crank gas-engines. It would appear that the practice was discontinued early in the present century, and that it had been confined chiefly to engines not exceeding 20 h.p. The 50 h.p. "Stockport" that I mentioned, was one of a pair that generated electric light for this town, from 1900 until about 1924, These engines had a high reputation for economy, but the bearings certainly gave trouble from running hot, I am inclined to think that this was due to the *dynamic* balance being uncorrected, as the heavy mass of the balance weight in the flywheel, rotating at about 220 r.p.m. and so much out of line with the crank, must have set up some very considerable strains.

Yours faithfully,

Witney, Oxon. J. BRICE.

DEGREASING PLANT

DEAR SIR,—I notice in a recent issue of THE MODEL ENGINEER, a letter from R.S.L. (Ilfracombe) regarding small degreasers. During the war, when employed in the laboratory of an engineering firm, I made several such degreasers, and, whilst I write from memory, I may be able to offer some assistance.

There is no difficulty in making quite small degreasers; the smallest we ever made was in an ordinary biscuit tin, and was quite successful.

It is desirable that the tank, if of any size, be rectangular rather than square; make the short side as small as is consistent with convenient working. The top of the condensing coils should be below the top of the tank by a distance equal to half the short side of the tank. This is to prevent the vapour overrunning the sides of the tank when the top is quickly removed, or if there is any draught.

As regards heating, allow plenty of surface area for the heater, if electric. If ordinary immersion heaters are to be used, wire two in series, giving double the surface for half the power. This is to prevent local overheating when the trichorethylene is getting dirty; it decomposes slightly to form hydrochloric acid, which corrodes the work otherwise.

If gas heating is to be used, rest the tank proper on a sheet of ¼-in. mild-steel plate, for the same reason. The use of about 2 per cent. of alcohol in the trichlorethylene helps to inhibit the formation of acid.

It is a good scheme to provide a perforated false bottom just above the level of the trichoroethylene, on which the work can be rested.

If the device is to be as simple as possible, and for occasional use only, nothing is required beyond the heater and the condensing coils; but, if required for fairly regular use on dirty or oily work, provide a gutter to catch the condensate from the coils, and pipe it through the side of the tank to a water separator (see sketch).

When the trichlorethylene becomes acid, or excessively dirty (this is shown by sluggish rising of the vapour level after work has been put in) put in an inch or two of 5 per cent.-10 per cent. soda solution, and distil off all the trichlorethylene. Drain out the soda solution, and clean the tank. Then return the now clean trichlorethylene (with a fresh addition of alcohol, if used), put a layer of water into the water separator, and the plant is ready for use again.

It must be remembered that trichlorethylene is a powerful anaesthetic, and the vapour heavy, so that anyone overcome by fumes would fall into the highest concentration. The moral is simply: have plenty of ventilation and a reliable water supply.

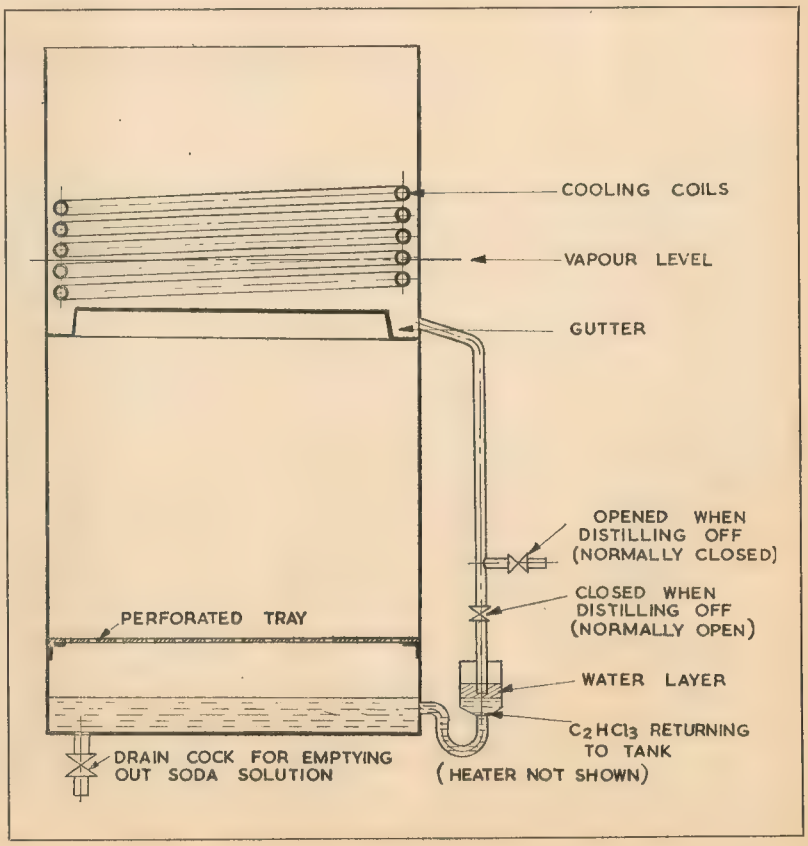
If trichlorethylene vapour is allowed to reach a flame, phosgene (very toxic irritant poison) is formed, so if gas heating is used, have the burner enclosed, and the fumes ducted outside the building.

As regards size of cooling coils, this naturally depends on the size of the plant; but for a tank 3 ft. × 1 ft. 6 in., I would suggest eight turns of ⅜-in. copper tubing, and adjust the heat input so that at rest the vapour line is not more than half-way up the coil.

If R.S.L. wishes to get in touch with me, I will gladly give any further advice I am able to.

Yours faithfully,

Lancaster. STANLEY, W. CARTER



RAILWAY SPEED

DEAR SIR,—The new French records at the almost incredible speed of 205.6 m.p.h. on the level are not only intensely interesting in themselves, but we have also been given some most valuable information.

As the descriptions of the locomotives and of the runs have been given elsewhere, it will suffice to say that two locomotives were involved, one a Co-Co type weighing 100 tons, of which the S.N.C.F. has many in service, and the other a Bo-Bo weighing 80 tons, one of four new experimental machines; both have much the same power, about 4,000 h.p. on continuous rating, and 4,700 at the one-hour rate. The trains were composed of three coaches weighing 100 tons, the same as used for the 151 m.p.h. record run last year, on which the Co-Co locomotive was also used.

Now while 4,000 h.p. sufficed for 151 m.p.h., no less than 12,000 h.p. was needed to attain 205 m.p.h. with a total load of about 200 tons. This may come as a surprise to many, but it really should not do so. What *does* seem much more remarkable is that the electric locomotive could be so versatile. That it should be possible to so overload the motors apparently only by field weakening and overgearing, that they can be forced to produce three times the horsepower of the continuous rating does seem astounding. Of course, such overloading could only be maintained for a very short time, and actually the 205 m.p.h. was only over a distance of 1¼ miles.

Yours faithfully,
Bexhill-on-Sea. C. M. KEILLER.

MINIATURE LOCOMOTIVE PERFORMANCE

DEAR SIR,—Mr. G. W. Vickerage, in THE MODEL ENGINEER issue of April 7th, introduces a welcome query. Let me say straight away that my comments on low coal and water consumption were based initially on a very marked impression of economy during runs when I was able to pay more attention to such matters, and less to the incessant clamourings of children demanding rides. The comparisons were made over a wide selection of engines using the track. The boasted economy, sweeping and arbitrary as it may seem, has its foundation in fact, and further steps are to be taken, if possible during the coming season, to supply observed data for those interested in such matters. I am glad, too, that Mr. Vickerage mentions track conditions and rail surfaces, for if friendly, competitive running is to continue in order to improve the breed of the miniature locomotive, then it must also supply proven figures of performance, economy and the like. Above all, it is essential that the many fine tracks used for such purposes around the country should be assessed or rated on a "Foot-poundage" basis, worked out mainly on the total rise of the track in its complete circuit. Such a formula, already in course of preparation, I might add, may soon be presented. It will allow for such things as the radii of the bends in the circuit, the actual gradients (as distinct from total rise) and certain other conditions affecting the running of locomotives and rolling stock.

Only by tackling the problem in this way will it be possible to observe and record reliable data, and that, I am quite sure, will be more than welcome to every unprejudiced adherent to the movement.

Whilst I have never been seriously troubled by slipping on the Beech Hurst track, even when heavily loaded, I have every sympathy with Mr. Vickerage and a few other visitors who have been less fortunate in this respect. Dare I suggest that slight modifications to the springing of the engines might do much to affect a partial if not a complete cure for this trouble? Rusty rails do, I know, provide the answer—but the mess on a wet day—and the service to the track during the winter! Oh dear, oh dear!

Yours faithfully,
Worthing. J. I. AUSTEN-WALTON.

An Independent Traversing Drive

(*Continued from page* 515)

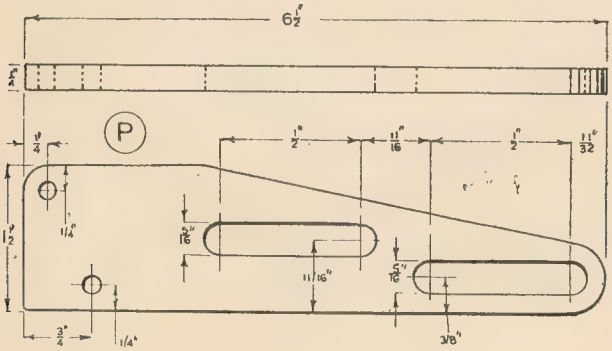
The worm-driven gearbox, to be described in the next article, gives a reduction ratio of 80 to 1, and the primary belt drive from the motor gives a further reduction of some 2 to 1.

The worm-wheel shaft can be fitted with a 20T change wheel which, through a 30T idler wheel, drives the 100T wheel secured to the spindle of the attachment for driving the leadscrew.

This arrangement provides a total reduction of 800 to 1 and, as the motor rotates at 3,000 r.p.m., the leadscrew will turn at approximately four revolutions a minute; this means that a leadscrew of 8 t.p.i. will traverse the lathe saddle at the rate of ½ in. a minute. When required, this rate of traverse can be increased by fitting a larger change wheel to the worm-wheel shaft, for clearly a slow rate of traverse will be needed when cutting teeth of coarse pitch on steel or cast-iron blanks, but a rapid traverse is more suitable for machining the fine teeth of brass gear wheels, when the milling cutter or fly-cutter is usually run at high speed. The length of the slot in the end of the arm *B* allows the centre distance between the worm-wheel shaft and the intermediate wheel stud to be extended to 2⅛ in., so that any wheel up to one having 50 teeth can replace the 20T wheel in the first stage of the gear train, giving a maximum rate of traverse of some 1¼ in. a minute.

When the worm box is moved outwards in the way, the belt line must be adjusted by sliding the motor arm *P* on its studs into a corresponding position; meanwhile, the belt tension can, if necessary, be reset by swinging the slotted arm *B* about its two attachment-screws.

(*To be continued*)



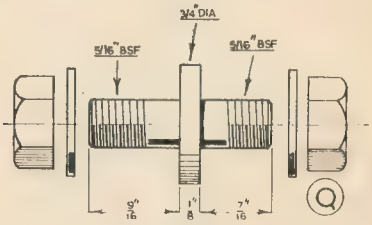


Fig. 21. The studs for attaching the arm (P) to the gear cover

Left—Fig. 20. The arm carrying the motor bracket

WITH THE CLUBS

Stephenson Locomotive Society

The 45th annual general meeting of this pioneer and old-established body was held at its permanent headquarters: Russell Road, Kensington, London, W.14, on April 2nd, the chairman, Mr. A. J. Boston, presiding. A short address by the president, Mr. J. N. Maskelyne, A.I.Loco.E., emphasised that the steam locomotive will find considerable spheres of usefulness for some time to come, and may indeed come back in some new form as the result of present researches.

The new Bristol centre is well established and it is proposed to raise the status of the Leeds branch to a separate area covering the West Riding. Local officers representing the London & Southern, North Western, Scottish, North Eastern & Midland areas reported busy years with selections of indoor and outdoor fixtures including lectures, discussions and film shows; visits to locomotive works, running sheds and industrial concerns; special train tours providing unique opportunities in the way of route and often haulage by veteran locomotives. Mr. R. A. H. Weight, publicity and publications officer, mentioned that the aggregate years of membership attained by the president, chairman, general secretary Mr. H. C. Casserley, treasurer Mr. F. H. Smith, and himself exceeded 180, but they were all "going strong."

A new catalogue of the society's extensive library and collection of relics is being prepared for circulation to members who receive a monthly illustrated journal which has just attained its silver jubilee of regular printed production.

For particulars of membership, please apply to the Gen. Secretary: H. C. Casserley, Ravensbourne, Berkhamsted, Herts, or area representatives.

Ashford & East Kent M.E.S.

At a recent exhibition held in Ashford by the local Rotary Club, the above society gained the following awards in their class:—

1st, J. Hanson, *Britannia.*
2nd, C. Butcher, Tank Loco.
3rd, O. Cheal, *Hielan' Lassie.*

Mr. J. Hanson also won the challenge cup for the best entry in the exhibition with his *Britannia.*

Hon. Secretary: C. Butcher, 63, Hythe Road, Ashford, Kent.

Tees-side S.M.E.E.

A meeting of the society was held at its headquarters in Middlesbrough on the April 4th, 1955, when a talk on "Photography" was given by Mr. C. M. Britton, B.Sc. The talk was of special interest from the fact that the speaker dealt fully with the technicalities of the photography of models, and to illustrate his points he utilised many photographs he had taken of models which members present had submitted for the purpose of an exhibition held quite recently.

Hon. Secretary: J W. Carter, 28, East Avenue, Billingham, Co. Durham.

Wicksteed Model Yacht and Power Boat Club

The Model Power Boat Regatta at Wicksteed Park, Kettering, will be held on July 3rd, commencing at 11.30 a.m.

Will club secretaries please note that the address of the secretary, Mr. Douglas Ward is now 12, Bryant Way, Higham Ferrers, Rushden.

The Brighouse S.M.E.E.

At a recent meeting, 35 members were entertained by a very interesting talk by Mr. H. Smith of Huddersfield. The speaker's subject was "Making Castings at Home in any Metal except Steel."

Our programme for the next three months is as follows:

Saturday, May 21st. Public Open Day, when everyone is very welcome.
Sunday, June 19th. Club Visiting Day.
Sunday, July 24th. Club Visiting Day.

Visitors to club functions are respectfully requested to make themselves known to any official on their arrival, when every endeavour will be made to make them feel at home and amongst friends.

Advance notification of visiting is an advantage to us, but not a necessity. Light refreshments always available.

Hon. Secretary: G. Harrison, 98, Park View, Rastrick Common, Brighouse.

Norwich & District S.M.E.

The next meeting of the above will be held at The Assembly House, Theatre Street, Norwich, on Wednesday, May 11th, 1955 at 7.30 p.m.

There are a few matters of business to be dealt with, including the arrangement of a provisional programme for the rest of the year, so it is hoped that as many members as possible will be present. To conclude the evening, there will be an informal general discussion.

By kind permission of British Railways, Eastern Region, a visit to the Motive Power Depot at Norwich Thorpe Station has been arranged and will take place on Saturday, May 14th, 1955, at 3.0 p.m.

Hon. Secretary: A. A. Taylor, 150, Furze Road, Thorpe, Norwich.

The Scottish Tramway Museum Society

It is proposed to form a tramway modelling/engineering section, and I would be pleased to hear from interested persons in the Glasgow area, and from those interested in any aspect of our work.

Hon. Secretary: Ian L. Cormack, "Largo," 80, Camp Road, Baillieston, Glasgow.

Harrow and Wembley S.M.E.

In spite of the dull weather, ten locomotives were out at the opening of the track season on Easter Monday. The first 2½-in. gauge locomotive was run over the recently completed circuit.

"Track Day," is the third Sunday in each month, when visitors are welcome.

Future arrangements:

May 11th. Marine Lecture by member of the Port of London Authority.

May 25th. General Section Meeting—Bring Your "Bits and Pieces."

Hon. Secretary: K. D. Carter, "Hedgeley," South Approach, Moor Park, Northwood, Middx.

Stockport and District S.M.E.

The annual general meeting of the society will be held at The Forester's Hall, Churchgate, Stockport, on Friday, May 6th, at 7.30 p.m. All members are particularly requested to attend. We have had a successful year and hope to make further progress during the 1955-56 season.

Hon. Secretary: D. Mapp, 163, Mauldeth Road, Withington, Manchester, 20.

The Gauge "1" Model Railway Association

The annual general meeting of the association will be held at 3.0 p.m. on Saturday, May 14th, in the Ambulance Room at Waterloo Station, S.E.1. Following the formal business, a track session will be held, and facilities will be available for both steam and electric running. It is hoped that as many members as possible will take this opportunity of giving their rolling stock a proving on the association's track.

On Thursday, May 26th, by invitation of the Model Railway Club, the association will stage a Track Night, also in the Ambulance Room at Waterloo, commencing at 7.30 p.m. Facilities will again be available for steam and electric running, and it is hoped to have as successful an evening as the last Track Night proved to be.

All enthusiasts interested in Gauge "1" will be welcome at these meetings, or they are invited to contact the Hon. Secretary: J. T. van Riemsdijk, at 40, Bancroft Avenue, London, N.2, for details of the association and its activities.

The Junior Institution of Engineers

The Junior Institution of Engineers invite entries for the annual Durham Bursary competition. Entrants, who must be over 19 and under 25 years of age, compete by submitting a thesis on some engineering, technical or scientific subject selected by the entrant. Further particulars of the bursary, which is valued at £20, in cash, may be obtained from the Institution at Pepys House, 14, Rochester Row, S.W.1.

THE MODEL ENGINEER DIARY

May 6th and 7th.—Crewe Model Engineering Society.—Exhibition of models in The Corn Exchange, Crewe.

May 8th.—Victoria Model Steamboat Club.—Regatta for straight running boats, at Victoria Park, London, E. Commencing at 11.0 a.m.

May 14th, 28th, 30th, June 11th and 25th.—Bristol Society of Model and Experimental Engineers.—Public days at the track, Canford Park.

May 22nd.—Forest Gate Model Power Boat and Engineering Society Regatta at Victoria Park, Hackney, London, E.9. Starting at 11.0 a.m.

May 28th.—Welling & District Model Engineering Society Regatta at the Belvedere Recreation Ground. Starting at 2.30 p.m.

May 30th.—Bournville M.Y & P.B.C.—Regatta at the Valley Pool, Bournville Lane, Birmingham. Starting at 11.30 a.m.

June 11th and 12th. — Birmingham Society of Model Engineers.—Annual National Rally of Steam Locomotives at the track at Campbell Green, 87, Horse Shoes Lane, Sheldon, Birmingham.

June 25th and 26th.—The West Riding Small Locomotive Society.—Rally of Model Locomotives, Gauges 2½ in. to 7¼ in., at Blackgates House, Bradford House, Tingley, Wakefield. Open from 10 a.m. to 10 p.m., both days.

July 9th.—Vickers-Armstrongs Limited (Weybridge) Model Club.—Annual exhibition, at Vickers-Armstrongs Limited, Sports Ground, Kings Head Lane, Byfleet, Surrey.

August 17th, 18th, 19th, 20th, 22nd, 24th, 25th, 26th and 27th.—The Model Engineer Exhibition, in the New Horticultural Hall, Greycoat Street, Westminster, S.W.1. Open from 11 a.m. to 9.0 p.m.

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This periodical is sold subject to the following conditions, namely, that it shall not, without the written permission of the publishers first given, be lent, resold, hired-out or otherwise disposed of by way of trade except at the full retail price of 9d., and that it shall not be lent, resold, hired-out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of trade; or affixed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

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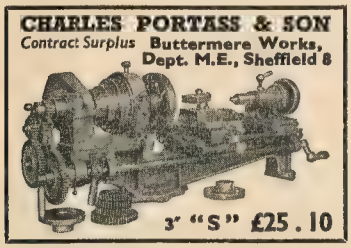

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Wanted. Little John Lathe, second-hand but in good condition. Please give age and accessories.—Box No. 7665, MODEL ENGINEER Offices.

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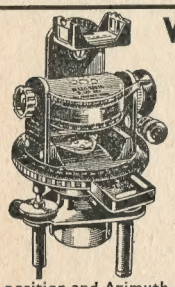

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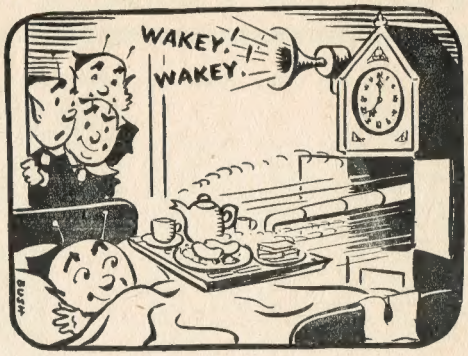

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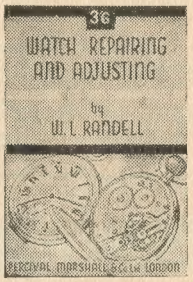

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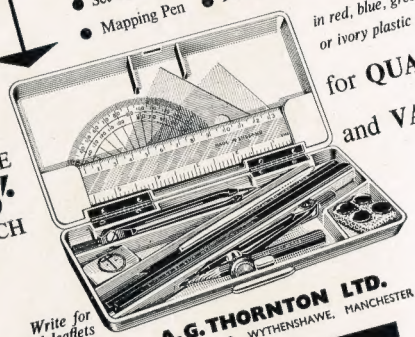

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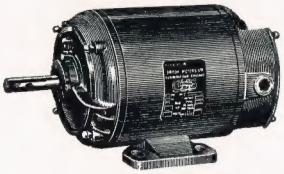

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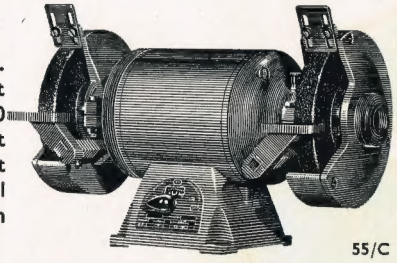

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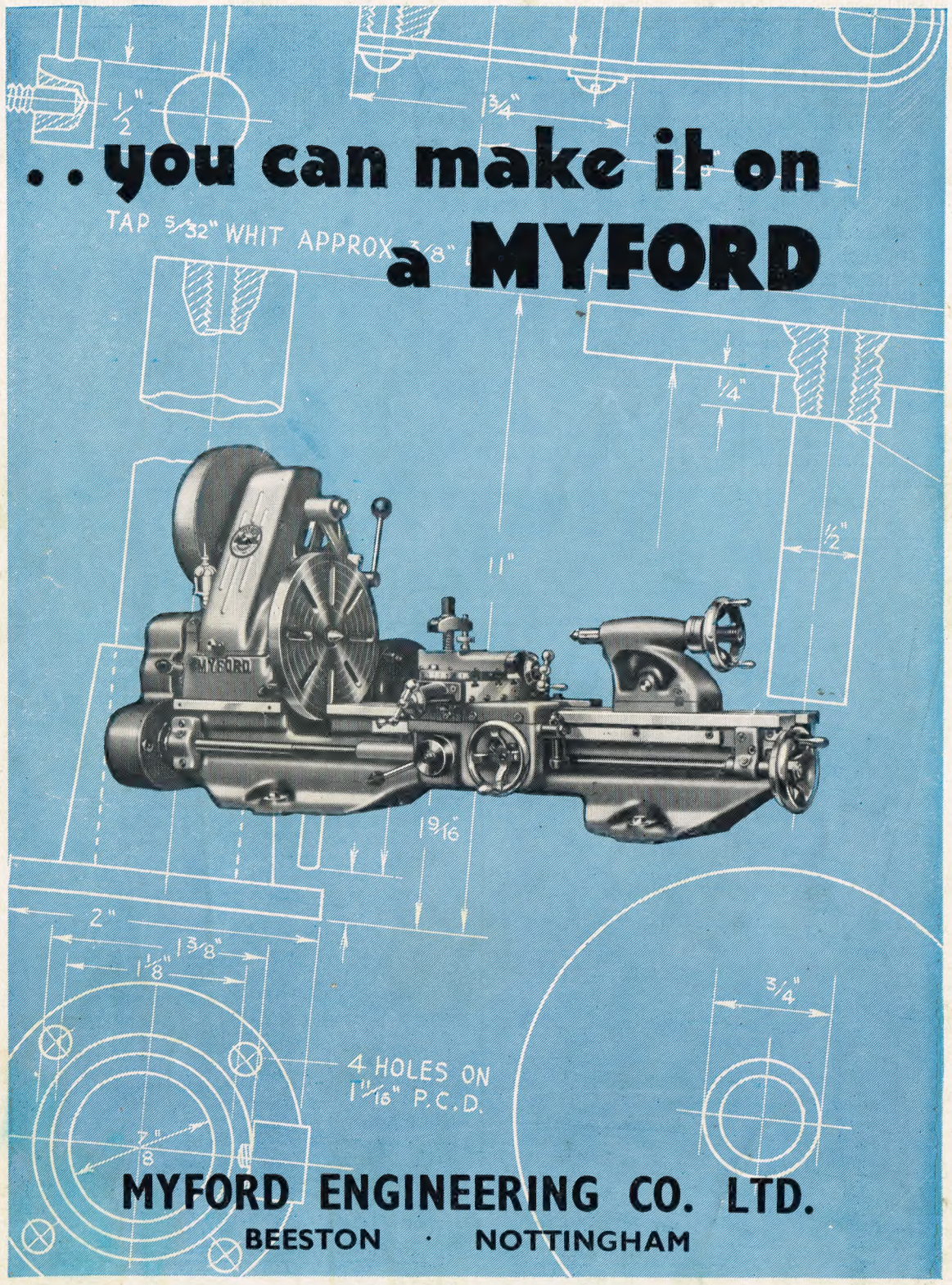
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